

# **Birla Central Library**

**PILANI (Jaipur State)**

**Engg College Branch**

Class No :- 692.5

Book No :- C 58B

Accession No :- 31715

Acc. No. . . . .

# ISSUE LABEL

*Not later than the latest date stamped below.*

~~00 AUG 78~~

9 AUG 78

3178

~~00 AUG 78~~



# BUILDING CONSTRUCTION ESTIMATING

*The quality of the materials used in the manufacture of this  
book is governed by continued postwar  
shortages*



# BUILDING CONSTRUCTION ESTIMATING

BY

GEORGE H. COOPER

*In Charge of the Estimating Classes at  
Mechanics Institute, New York City*

*First Edition*

FOURTH IMPRESSION

McGRAW-HILL BOOK COMPANY, INC.  
*New York* *London*

1945

BUILDING CONSTRUCTION ESTIMATING

COPYRIGHT, 1945, BY THE  
MCGRAW-HILL BOOK COMPANY, INC.

PRINTED IN THE UNITED STATES OF AMERICA

*All rights reserved. This book, or  
parts thereof, may not be reproduced  
in any form without permission of  
the publishers.*

CP-185  
non

652.5  
C58 B  
31715

6187

C166

*The author dedicates this book to*

**LOUIS ROUILLION**

Director of Mechanics Institute

Whose fine leadership and stimulating  
guidance have made Mechanics Institute  
one of the great schools of the country



## PREFACE

The material in this textbook has been used with success, in three preliminary editions, by the author's classes at Mechanics Institute, New York City. In preparing the present edition, it was felt that other schools would find the book well arranged and useful for their purposes.

It is intended to be a standard textbook for a full course in technical and vocational schools and also for intensive study by properly qualified students in technical schools and colleges. Such students should be high-school graduates and should have at least two years of architectural drafting to their credit.

Many books on estimating consider in great detail the design and construction of buildings, mathematics, specification writing, mechanical trades, and elementary plan reading. The present book is based on the principle that a textbook should be complete only in the matters before the class and should not treat in detail anything that is regularly handled in other classes. Because there is no other book on estimating that meets this test, the present book should be found acceptable by teachers and students desiring a thorough textbook treatment without cumbersome detail.

The practical requirements of the classroom have been given consideration throughout. The book forms a complete working plan for the instructor and contains all the required material, including two sets of plans, many specimen estimates, hundreds of construction terms, and all essential reference data. The numerous illustrations will enable the student to visualize better what is being discussed. The exercises are not too many for a regular class to handle completely.

Chapters I to IX discuss contracting as a business, building codes, plans, specifications, contracts, and the general technique of estimating. This material comprises the first half of the course. Chapters X to XVII deal with the estimating of work that is customarily performed by the general contractor's own men. Chapters XVIII to XXIV treat of the work usually done by the subcontractors' men.

The aim is to present in orderly sequence a well-rounded course covering the everyday work of the building contractor's estimator. The final chapter deals with the terminal aspect of the course. The challenge "Are you an estimator?" gives the student a strong motive for learning. The comprehensive examination, with plans, provided in this chapter will enable him to place a definite and practical value on his attainments.

This final examination might instead be based on a set of selected blue-printed plans. In that event, the plans in the chapter should form the basis of classwork or homework during the final months of the course.

A full set of specifications, as for a modern business building or factory, would require as many pages as this entire text and might also confuse the student. For these reasons it seemed best to include only the essential extracts, which may be elaborated upon as desired by the instructor. Several complete sets of plans and specifications should be available in the classroom for additional drill and test purposes. These plans will last longer if they are printed on cloth or mounted. Complete estimates for several types of buildings should be available to show their general form and arrangement. Copies of the local building codes also should be available. The final month or two of the course should be spent on these, and every student should be required to prepare at least four complete estimates, each for a different type of building.

It is also suggested that full-size samples of many building materials should be on hand in the classroom where the students may see and feel them, especially if they are not provided in concurrent classes. Models of different forms of construction and large-scale drawings will also be found helpful and should be used to illustrate the instructor's lectures.

The following reference books should be available and should be used in the classroom and for homework assignments:

"Handbook of Building Construction," by Hool and Johnson, 2d ed., McGraw-Hill Book Company, Inc., *or*

"Architects and Builders Handbook," by Kidder-Parker, 18th ed., John Wiley & Sons, Inc.

"Standard Construction Methods," by G. Underwood, 2d ed., McGraw-Hill Book Company, Inc., *or*

"Materials and Methods of Architectural Construction," by Gay and Parker, 2d ed., John Wiley & Sons, Inc.

"Architectural Graphic Standards," by Ramsey and Sleeper, 2d ed., John Wiley & Sons, Inc.

"Business Methods in the Building Field," by Schobinger and Lacker, McGraw-Hill Book Company, Inc.

"Estimating Building Costs," by Frank E. Barnes, 3d ed., McGraw-Hill Book Company, Inc., *or*

"Estimating Building Costs," by William Arthur, 3d ed., Scientific Book Corporation, *or*

"The Estimator's Reference Book," by Frank R. Walker, 8th ed., Frank R. Walker Co., Chicago.

Although the arrangement and contents of this book are original, and the illustrations all especially made for it, the author wishes to acknowledge his indebtedness to all the books and manufacturer's catalogues which he examined for ideas. No names of manufacturers or of their products are mentioned either in the text or in the illustrations, nor has any effort been made to favor the use of any particular materials.

GEORGE H. COOPER.

NEW YORK,  
*April, 1945.*



# CONTENTS

|   |             |
|---|-------------|
| PREFACE . . . . .   | PAGE<br>vii |
| <i>Chapter I</i>  |             |
| INTRODUCTION. . . . .   | 1           |
| THE ESTIMATOR—HIS WORK—STUDY OF ESTIMATING—PRACTICALITY OF COURSE—METHOD  |             |
| <i>Chapter II</i>   |             |
| CONSTRUCTION RELATIONS. . . . .   | 4           |
| MEN CONCERNED WITH BUILDING WORK—OWNER—ARCHITECT—CONTRACTORS—MATERIAL MEN—CITY DEPARTMENTS—SUPERVISORS—WORKMEN—WAGE SCALE   |             |
| <i>Chapter III</i>  |             |
| THE ARCHITECT. . . . .  | 9           |
| DUTIES—OFFICE—PERSONNEL—TYPICAL OFFICES—LICENSE—INSPECTION OF CONSTRUCTION—SPECIFICATIONS   |             |
| <i>Chapter IV</i>   |             |
| THE CONTRACTOR. . . . .   | 17          |
| THE BUSINESS OF CONTRACTING—GENERAL CONTRACTOR—CONSTRUCTION COMPANY—STAFF ORGANIZATION—TYPICAL OFFICES—SYSTEM—FORMS   |             |
| <i>Chapter V</i>  |             |
| PLANS AND PLAN READING. . . . .   | 26          |
| BLUEPRINTS — ARCHITECTURAL PLANS — STRUCTURAL — MECHANICAL — FLOOR PLANS — ELEVATIONS — SECTIONS — DETAILS — SCALES — SYMBOLS — INDICATIONS — SET OF HOUSE PLANS — BUILDING CODES |             |
| <i>Chapter VI</i>   |             |
| CONTRACTS. . . . .  | 54          |
| LEGAL DEFINITION—MANAGEMENT TYPE—LUMP-SUM TYPE—PROVISIONS—FORMS—PAYMENTS—ARBITRATION  |             |

*Chapter VII*

|   |            |
|---|------------|
| TECHNIQUE OF ESTIMATING . . . . .   | PAGE<br>61 |
| PRELIMINARY BIDDING AND WORKING ESTIMATES—ANALYZING<br>PLANS AND SPECIFICATIONS—EXAMINATION OF SITE—BIDS FROM<br>SUBCONTRACTORS—TRADE CUSTOMS—UNFAIR DEALINGS |            |

*Chapter VIII*

|  |    |
|--|----|
| QUANTITY SURVEYING. . . . .  | 74 |
| FORMS—GROUPING THE ITEMS—KEY HEADINGS—SCALE RULES<br>—MATHEMATICS—CHECKING—NOT A MATERIAL LIST |    |

*Chapter IX*

|   |    |
|---|----|
| EXPENSE AND SUMMARY SHEETS . . . . .  | 81 |
| GENERAL JOB EXPENSE ITEMS—SUPERVISION—WORKING FA-<br>CILITIES—ENGINEERING—BONDS—INSURANCE—LABOR LAWS—<br>MAIN OFFICE—PROFIT |    |

*Chapter X*

|   |    |
|---|----|
| EXCAVATING. . . . .   | 95 |
| ORIGINAL AND FINISH GRADES—GENERAL EXCAVATING—<br>TRENCHES—PITS—DIFFICULT EXCAVATIONS—SHEET PILING—<br>ROCK |    |

*Chapter XI*

|  |     |
|--|-----|
| CONCRETE FOUNDATIONS. . . . .  | 101 |
| FORMS—REINFORCING—CONCRETE—FOOTINGS—WALLS—<br>ORDINARY CONCRETE—CONTROLLED CONCRETE—WEIGHTS OF<br>REINFORCING RODS |     |

*Chapter XII*

|   |     |
|---|-----|
| CONCRETE FLOORS AND ROOFS. . . . .  | 113 |
| STEEL FIREPROOFING—FORMS—MESH—COLUMNS—GIRDERS—<br>BEAMS—SLABS—RODS—PAN SYSTEM—BLOCK FILLERS—<br>INSERTS |     |

*Chapter XIII*

|   |     |
|---|-----|
| MASONWORK. . . . .  | 128 |
| COMMON BRICK—FACE BRICK—ENAMELED BRICK—BONDS—<br>ARCHES—TERRA COTTA—GYPSUM—CONCRETE BLOCKS—FLUE<br>LINING—COPINGS—IRON ITEMS—CAULKING—WATERPROOFING<br>—SCAFFOLDING |     |

*Chapter XIV*

|  |             |
|--|-------------|
| ROUGH CARPENTRY . . . . .  | PAGE<br>155 |
| LUMBER—FRAMING—BALLOON AND BRACED TYPES—BOARD<br>MEASURE—STOCK SIZES—WASTE—GRADING—BEAMS—STUDS—<br>SHEATHING—UNDERFLOORING—TRUSSES |             |

*Chapter XV*

|   |     |
|---|-----|
| CEMENT WORK. . . . .  | 179 |
| FLOORS AND PAVEMENTS ON GROUND—FLOOR AND ROOF FILL—<br>FINISH FLOORS—CEMENT BASE—HARDENERS AND COLORS—EX-<br>PANSION JOINTS |     |

*Chapter XVI*

|  |     |
|--|-----|
| PLASTERING . . . . .   | 188 |
| METAL LATH — WOOD LATH — CORNER BEADS — PLASTER —<br>STUCCO—CORNICES—GROUNDS—HUNG CEILINGS |     |

*Chapter XVII*

|  |     |
|--|-----|
| FINISH CARPENTRY . . . . .   | 195 |
| MILLWORK — TRIM — CABINETWORK — FLOORING — WASTE —<br>QUALITY—STOCK ITEMS—CONSTRUCTION DETAILS |     |

*Chapter XVIII*

|  |     |
|--|-----|
| STEEL AND IRON. . . . .  | 210 |
| WEIGHTS OF STEEL—COLUMNS—BEAMS—ANGLES—LINTELS—<br>ERECTION—STAIRS—RAILINGS—TRUSSES |     |

*Chapter XIX*

|  |     |
|--|-----|
| ROOFING AND SHEET METAL. . . . .   | 218 |
| ROOF COVERINGS—FLASHINGS—REGLETS—SKYLIGHTS—<br>SCREENS—DUCTS—LEADERS—GUTTERS—CORNICES—WATER-<br>PROOFING |     |

*Chapter XX*

|   |     |
|---|-----|
| STONEWORK . . . . .   | 226 |
| GRANITE—LIMESTONE—BLUESTONE—CAST STONE—RUBBLE<br>STONE—ASHLAR |     |

*Chapter XXI*

|   |     |
|---|-----|
| FIREPROOF DOORS AND WINDOWS . . . . .   | 228 |
| KALAMEIN—TINCLAD—HOLLOW METAL—PRESSED-STEEL<br>FRAMES—ROLLING STEEL DOORS—STEEL WINDOWS—FIRE UN-<br>DERWRITERS—STORE-FRONT CONSTRUCTION |     |

Chapter XXII

|  |             |
|--|-------------|
| TILE, TERRAZZO, AND MARBLE . . . . .           | PAGE<br>235 |
| FLOORING—BASE—WAINSCOTING—BATHROOM ACCESSORIES |             |

Chapter XXIII

|   |     |
|---|-----|
| PAINTING, GLAZING, AND HARDWARE . . . . .   | 236 |
| PLAIN PAINTING—SPECIAL FINISHES—FLOOR SCRAPING AND<br>FINISHING — GLAZING — PLATE GLASS — STRUCTURAL GLASS —<br>FINISH HARDWARE |     |

Chapter XXIV

|   |     |
|---|-----|
| THE MECHANICAL TRADES . . . . .   | 239 |
| PLUMBING—HEATING—ELECTRIC—AIR CONDITIONING—POWER<br>—LIGHTING FIXTURES—SEWERS—ELEVATORS |     |

Chapter XXV

|   |     |
|---|-----|
| ARE YOU AN ESTIMATOR? . . . . .   | 248 |
| REVIEW — ADVICE — REQUIREMENTS AND EXAMINATION FOR<br>JUNIOR ASSISTANT—ASSISTANT ESTIMATOR—ESTIMATOR—BANK<br>AND OFFICE BUILDING SPECIFICATIONS AND PLANS |     |
| INDEX . . . . .   | 275 |

# BUILDING CONSTRUCTION ESTIMATING

## CHAPTER I INTRODUCTION

**Building construction estimating** requires a working knowledge of all phases of building work. The serious student of estimating may therefore be said to have an excellent opportunity to make a good general study of building work. As nearly every man will find this knowledge useful at some time or other, whether or not he is directly connected with the building industry, it will readily be seen that the practicality of a course in estimating can hardly be overemphasized.

**The estimator** in a well-organized contractor's office is usually the center of activity in the office. From the time the office makes the first contact regarding a proposed building until the job is well under way, the estimator is in control. He may even have to make the contacts. His first duties include quantity surveying, interviewing subcontractors, obtaining quotations on materials, and preparing the estimate. He then submits the bid and follows through to secure the contract. He has to make adjustments quickly and therefore must have his records in fine order and his wits about him all the time. His work is important at all stages.

Before the work at the job can begin, the estimator prepares the working estimate, the material lists, and the construction schedule. He is in constant touch with sources of supply, as it is his duty to award the subcontracts and to supervise the purchasing of materials. Unless these are properly and promptly taken care of, there is much waste energy all along the line afterward. The saying "a job well begun is half done" applies very aptly here, as many a job has been bungled merely because it was given into the superintendent's hands before it had been properly started in the office.

When the job gets under way, the general superintendent has control and the estimator gradually relinquishes his hold, in order that he may put his time to use in securing other contracts. A good estimator will see that complete plans and specifications, copies of all subcontracts,

and all other required data are given to the superintendent. He will make sure that every adjustment has been made in the records up to the time that he thus turns them over to the superintendent. He will clarify all points about which he thinks there may be any question or which may tend to slow up the progress of the job. He will insist upon his records being so complete at the time of their final release by him that nobody can hold him responsible for what happens afterward.

**This course** is for the practical purpose of training students in the everyday work of the building contractor's estimator. The plan is to cover the entire ground as thoroughly as possible in the time given to the subject. The textbook, which contains all the material required for a complete presentation of the principles underlying this subject, is planned for classroom use and home study under the direction of a teacher.

Two complete sets of plans are included and will be referred to in the text. These plans illustrate many kinds of materials and several types of construction. Detail drawings are included in the chapters in which the work shown by the details is discussed.

Specimen estimate sheets will be found in all the chapters dealing with the estimates. These illustrate the recommended method of making the entries required in each of the various lines of work. Each student individually should do all the actual measuring of the plans, and each should make all the entries in the estimates. In this way the plan indications, units of measure, and methods of scaling the plans will be brought out forcefully.

The hundreds of construction terms treated in the text are those commonly used by architects, contractors, and others concerned with building work everywhere. The student should realize that these form the heart of the construction man's language. As they are tied in with the text and the estimating work throughout the course, every serious student will have an opportunity to enrich his vocabulary by including in it these new words and expressions. They will probably be of more practical value than the same number of words learned in a class in English literature.

Exercises, given at the end of each chapter, are based upon the work of the chapter. They should, therefore, be worked out thoroughly by every student while the chapter is being studied. In this way the weak points of the instruction or of the study will appear and can be reviewed before the next chapter is started. The last chapter in the book contains final examination directions and problems and represents the goal of the course.

Many unit costs are given in the text and in the specimen estimates. These are for the purpose of making the work more realistic and may be

employed for pricing the estimates. However, it should be borne in mind that costs vary, owing to many causes that will be discussed in the text; and these unit costs should not be treated as permanent references for actual pricing of work.

This is a practical course and the students should react by asking questions and looking up information because of their interest in the practical nature of the work. Thus will be fulfilled the conditions that facilitate the acquisition of knowledge: a determination to know, an active mind, and an effective method of study. As the student increases in power, imitation must gradually decrease and reason play an ever-increasing role. The students are urged to discuss the work among themselves as well as with the teacher; in fact, they should work in pairs, if possible, always being sure, however, that each member of the pair goes through all the motions of the estimating process individually.

#### **Exercises**

1. Briefly, what are the duties of an estimator?
2. Up to what point is an estimator in control of a building operation?
3. What should the estimator do for the good of the job and for his own safety when relinquishing control?
4. Look over some of the books on estimating, such as those listed in the Preface to this textbook. Write at least 100 words of notes on an introduction to estimating. Name the books that you have used for this purpose.

## CHAPTER II

### CONSTRUCTION RELATIONS

**The construction of a building** involves many kinds of administrative and technical skills. This is a fact that is not often fully appreciated by the general public or even by businessmen in other lines of work. They see a building going up, but seldom have an opportunity to look behind the scenes and observe the working of the system that makes possible the construction of the building—the activity in the various departments of the architect's, the contractor's, and the subcontractors' offices.

In a contractor's office there are much careful planning and scheduling to be done, equipment to be arranged for, and materials to be purchased and coordinated as to sequence of delivery. The field working force must be organized anew for each project, and definite arrangements must be made for pay rolls, accounting, insurance and tax records, in connection with this floating population of workers on the job.

It is the contractor's skill and the use of his business and technical organization that the owner buys when he signs a construction contract. A contractor who attempts to operate without proper skill and without a proper business and technical organization is under a very great handicap.

The chart on the following page (Fig. 1) shows the usual relationship that exists between the men who are concerned with the design and the construction of an average building job. This study is from the general contractor's viewpoint and, therefore, the main line of action is shown running through the contractor's organization, as the chart indicates. The contractor looks to the owner as the man who pays him and as the one he wants to satisfy regarding the particular job.

**The architect** is the man who makes the plans. He also writes the specifications that accompany the plans and that further describe the work. He is engaged and paid by the owner to do this planning and to look after the owner's interests in connection with the building work.

At the beginning, the architect has dealings with the owner alone, preparing preliminary sketches and then making the regular plans and writing the specifications. After this is done, the general contractor comes upon the stage. He is asked to submit a bid for the job of constructing the building. Usually, the architect invites the contractors to bid, although sometimes the owner does this.

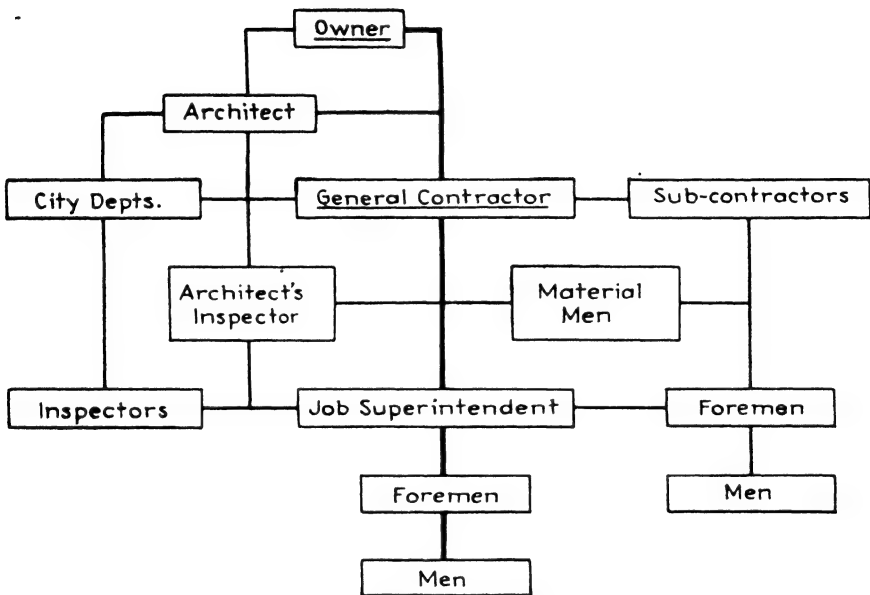


FIG. 1.—Construction relations.

Contractors are very likely to know about the job before it is time for bids, because they are always following up trade reports and other leads toward jobs and are constantly in touch with a number of architects and others who frequently have work to be estimated. As public contracts have to be legally advertised, one can always know about this class of work at least 10 days before the bids are due.

The architect lends each invited contractor a set of plans and specifications, in order that each one may prepare his estimates on which to base bids. After the contract between the owner and the successful contractor is signed, this contractor looks to the architect for further information regarding the work to be done and for detail plans, etc. He soon finds that he has both the owner and the architect to satisfy.

The architect sends a man from his office to act as his inspector on the job. This man is sometimes referred to as the "architect's superintendent." The contractor has his own superintendent on the job to handle the various trades and to lay out the work, to order material as required, and to manage the subcontract work, etc. The contractor's superintendent has continual contact with the architect's man and with the inspectors from the municipal departments that have jurisdiction over the work of constructing buildings.

**The municipal departments** are visited by the architect, as he has to file applications and plans in order to enable the contractor to secure a permit for the erection of the building. The contractor also visits them to get this and various other permits that contractors are required to have. After the job starts, it will be visited by the inspectors from these departments—and the contractor will have them to satisfy too!

Local laws always include regulations governing building work, which are generally referred to as "building codes." The building code states the minimum requirements regarding the design, construction, and use of buildings and other structures. Safe and sanitary buildings are required. The size and kind of materials for walls, floors, roofs, plumbing, etc., are given in the code.

**Subcontractors** are men or firms who do work for the general contractors. This may be work that the general contractor does not wish to do; or work that he has not the facilities to do with his own men; or, perhaps, work for which he has not the required license. Steel, iron, roofing, sheet-metal, plumbing, heating, and electrical work are some of the lines that are commonly sublet in this way. The subcontractors send their men and materials for the work they do on the job. The general contractor's superintendent sees that they do their work on time and in harmony with the other lines of work.

In small towns, where there are very few inspectors from the municipal departments, one man often acts as the whole personnel of the building

department. Similarly, in small places there are fewer subcontractors than in large cities. In such cases the general contractors employ men for most of the trades directly, instead of giving the work out to subcontractor specialists. In the very large cities there seem to be subcontractors without end: for wood flooring, for just scraping and finishing wood floors, for doing only the cement-finish work, for caulking, and for many other items of work that would ordinarily be done by the general contractor's men in a smaller place.

## EMPLOYEE CLASSIFICATIONS

| Classification                      | Rates per hour                     | Classification                    | Rates per hour                   |
|-------------------------------------|------------------------------------|-----------------------------------|----------------------------------|
| Air-tool operator.....              | \$1.14 <sup>2</sup> / <sub>7</sub> | Painter.....                      | \$1.60                           |
| Asbestos worker.....                | 2.00                               | Plasterer.....                    | 2.00                             |
| Asbestos worker's helper.....       | 1.50                               | Plasterer's helper.....           | 1.42                             |
| Barman (wrecking).....              | 1.25                               | Plumber.....                      | 1.50                             |
| Barman's helper.....                | 1.15                               | Plumber's helper.....             | .68 <sup>3</sup> / <sub>4</sub>  |
| Boilermaker.....                    | 1.90                               | Sheet metalworker.....            | 1.65                             |
| Boilermaker's helper.....           | 1.60                               | Slate and tile roofer.....        | 1.86                             |
| Bricklayer.....                     | 2.00                               | Slate and tile roofer helper..... | .96                              |
| Bricklayer's helper.....            | 1.21 <sup>3</sup> / <sub>7</sub>   | Steamfitter.....                  | 2.00                             |
| Cable splicer.....                  | 1.50                               | Steamfitter's helper.....         | 1.50                             |
| Carpenter.....                      | 1.60                               | Stonecutter.....                  | 1.68 <sup>3</sup> / <sub>4</sub> |
| Caulker (pipe).....                 | 1.15                               | Stonemason.....                   | 1.90                             |
| Cement finisher.....                | 1.85                               | Stone setter.....                 | 2.00                             |
| Cement and concrete worker.....     | 1.21 <sup>3</sup> / <sub>7</sub>   | Structural ironworker.....        | 2.00                             |
| Composition roofers.....            | 1.54 <sup>2</sup> / <sub>7</sub>   | Structural iron apprentice.....   | 1.30                             |
| Composition roofer's helper.....    | .96                                | Tile layer.....                   | 1.68 <sup>3</sup> / <sub>4</sub> |
| Curb setter.....                    | 1.65                               | Tile layer's helper.....          | 1.25                             |
| Derrickman (stone).....             | 1.65                               | Timberman.....                    | 1.25                             |
| Dock builder.....                   | 1.75                               | Weatherstripper.....              | 1.60                             |
| Electrician.....                    | 1.71 <sup>3</sup> / <sub>7</sub>   | Equipment Operators               |                                  |
| Elevator constructor.....           | 1.85                               | Air compressor, single.....       | 1.75                             |
| Elevator mechanic.....              | 1.53                               | Air compressor, battery.....      | 1.92 <sup>1</sup> / <sub>2</sub> |
| Elevator constructor's helper.....  | 1.35                               | Hoist.....                        | 2.00                             |
| Elevator mechanic's helper.....     | 1.09                               | Concrete mixer, small.....        | 1.21 <sup>3</sup> / <sub>7</sub> |
| Glazier.....                        | 1.88 <sup>3</sup> / <sub>4</sub>   | Concrete mixer, large.....        | 1.92 <sup>1</sup> / <sub>2</sub> |
| Laborer, common.....                | .81 <sup>1</sup> / <sub>4</sub>    | Power saw.....                    | 1.60                             |
| Laborer, concrete.....              | 1.21 <sup>3</sup> / <sub>7</sub>   | Pump.....                         | 1.65                             |
| Manhole builder.....                | 2.00                               | Tractor.....                      | 1.65                             |
| Marble carver.....                  | 2.07 <sup>1</sup> / <sub>7</sub>   | Truck.....                        | 1.00                             |
| Marble cutter and setter.....       | 1.75                               | Scraper.....                      | 1.65                             |
| Marble polisher.....                | 1.57 <sup>1</sup> / <sub>7</sub>   | Bulldozer.....                    | 1.65                             |
| Metal lather.....                   | 1.75                               | Blade grader.....                 | 1.65                             |
| Mosaic and terrazzo worker.....     | 1.75                               | Crane.....                        | 1.65                             |
| Ornamental ironworker.....          | 1.75                               | Derrick.....                      | 1.65                             |
| Ornamental ironworker's helper..... | 1.30                               | Shovel.....                       | 2.12 <sup>1</sup> / <sub>2</sub> |

**Material man** is the term used to denote any of the men or concerns that merely sell the materials used in building work. The lumber dealer is a material man. He sends the lumber to the job but does not send the carpenters who install it. The mason supply yard, the sand and gravel company, the hardware dealer, and all others from whom materials are bought are called "material men" and are thus distinguished from subcontractors, who do actual work on the jobs.

The subcontractors themselves use the material men—for supplying their own men with materials. Thus, it may happen that occasionally the same material men will send material to the same job, both for the general contractor's use and for use by one or more of his subcontractors. The same mason supply man may send bricks and cement for the general contractor's mason-work and plastering materials for the subcontractor who is doing the plastering.

**The mechanics** are the men who work with tools on the job. Helpers or apprentices also are employed in some trades. "Laborer" is a broad term, used not only to apply to the men who do the ordinary heavy work about the job, but also to refer to helpers and apprentices. A bricklayer's helper, for example, is often referred to as a laborer.

The list of the employee classifications found on large jobs, together with their rates of wages, is shown on page 7. The rates are given here merely so that the student may become somewhat familiar with them; naturally, they do not apply in all parts of the country. The whole field of industrial relations and business economics is undergoing a change. Workmen on construction jobs are being unionized in practically every part of the country. The rates shown are union rates per hour that apply in some localities.

### Exercises

1. Make a chart showing the relationship between men on an average job or, if possible, on a job with which you are familiar.
2. State the relationship of subcontractors to a job and name at least six lines of work that are commonly sublet.
3. What is a material man? Name several kinds. Do material men send men to work on the job?
4. State what the term "mechanic" means as used in building work, and name six trade classifications of mechanics.
5. Name 10 positions held by men on a building job who are not employed by the general contractor.
6. Write at least 100 words of notes on the men concerned with building work, taken from one or two of the books listed in the Preface. Name the books used.

## CHAPTER III

### THE ARCHITECT

**The architect's duties** have been partly set forth in Chap. II, which shows his relations with the group of men concerned in a building operation. He furnishes the drawings and specifications necessary for the proper prosecution of the work and also any additional drawings, details, and directions required as the work proceeds, except the shop drawings. He usually has the power to make decisions upon all the contracting parties and upon all controversies arising under the contract.

"Shop drawing" is the general term applied to all plans and details prepared by the contractor and his subcontractors and material men. The millwork details submitted by the material man for the millwork are shop drawings. The fabrication details and setting plans prepared by the structural steel and miscellaneous ironwork subcontractors are shop drawings.

The architect inspects and passes upon the work and determines whether it is in accordance with the contract and with his plans and specifications. He has the power to make decisions relative to the progress of the work and to determine the time to be allowed for changes that are approved by the owner. If he thinks such action is necessary for the proper execution of the contract or for safeguarding the work from injurious weather conditions, he may suspend the work until the causes of suspension have been removed.

The architect has the power to determine allowances for changes in the work ordered by the owner. He has the power to act as the owner's agent in emergencies affecting the safety of limb or property and to order any work necessary to meet such emergencies. He certifies as to the amounts due to the contractor and has the power to withhold payments to protect the owner from loss that is due to failure on the part of the contractor to meet obligations under the contract.

**The architect's office** personnel consists of a head draftsman, several other draftsmen, and at least one general assistant. The head draftsman works in close conjunction with the architect in preparing the preliminary sketches and in studying the client's requirements, as well as in the general designing and planning. The regular draftsmen complete the drawings and make the tracings.

In architectural offices there is always ample provision for drafting work. Even a small office will have several drafting tables. In addition,

there are plan files, sample cabinets, bookcases, and other special equipment, as well as the usual desks, files, typewriters, etc., that are common to all offices.

Generally, either the architect or his head draftsman does all the specification writing. This is a sort of one-man specialty, as it involves not only continual contact with manufacturers' representatives, but also the proper coordinating of all the building work described under the different specification headings.

In large architectural offices there are designers, squad leaders, draftsmen, tracers, detailers, engineers, structural draftsmen, mechanical

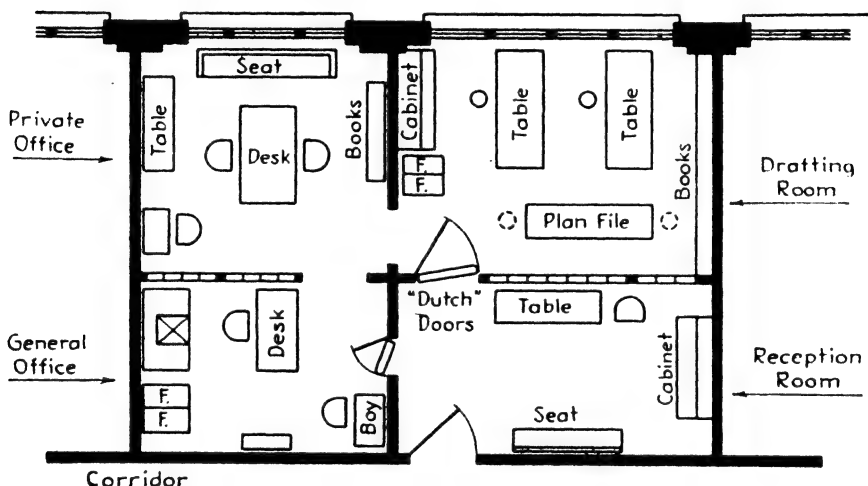
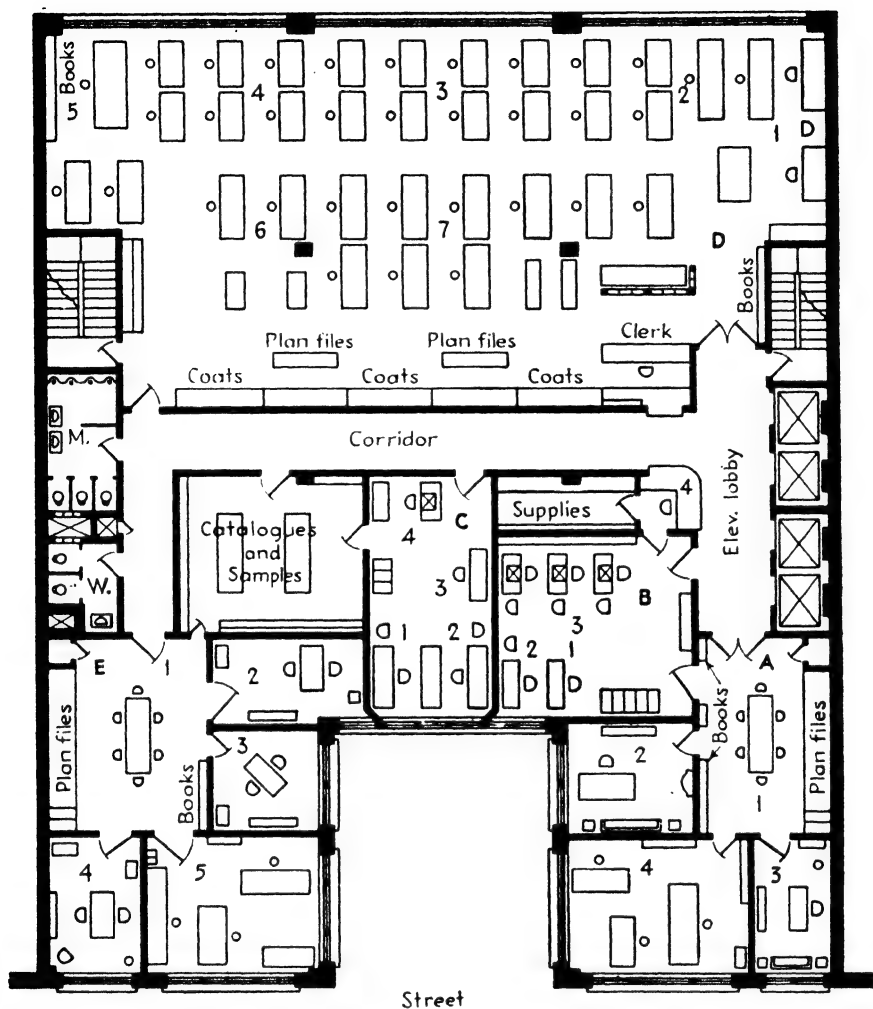


FIG. 2. - An architect's office.

draftsmen, checkers, etc. Such offices are often highly organized. Figure 3 shows the layout of offices for a firm of architects and engineers that handles the design of large industrial plants, as well as the general run of architectural work.

**A license** is required. In practically all states it is unlawful for any person to practice or to offer to practice architecture unless he has been duly licensed as an architect. Engineers, as such, may also obtain licenses, and they then have almost the same powers and duties as architects in connection with building work.

In New York State, licenses are issued by the State Education Department. To secure a license as architect the applicant must submit evidence that he is at least twenty-five years of age and a citizen of the United States. Besides, he must have completed an approved four-year high-school course or its equivalent, as determined by the State Education Department, plus the satisfactory completion of two years in an



## A-Architectural Dept.

- 1 Conference Room
- 2 Architect
- 3 Architect
- 4 Design Room

## B-General Office

- 1 Manager
- 2 Bookkeeper
- 3 Stenographers
- 4 Information

## C-Construction Dept.

- 1 Specification Writer
- 2 Contract Clerk
- 3 Construction Supt.
- 4 Stenographer

## D-Drafting Room

- 1 Chief Draftsman
- 2 Planning
- 3 Draftsmen
- 4 Detailers
- 5 Engineers
- 6 Checkers
- 7 Tracers

## E-Engineering Dept.

- 1 Conference Room
- 2 Civil Engineer
- 3 Mechanical Engineer
- 4 Electrical Engineer
- 5 Design Room

FIG. 3. A firm of architects and engineers.

institution registered as maintaining satisfactory standards, conferring the degree of bachelor of arts or science, or the equivalent.

The applicant must submit satisfactory evidence to the Board of Regents of at least five years' practical experience in the office of a reputable architect, commencing after the completion of the high-school course of study. The law in New York also provides that, notwithstanding all else, every applicant shall establish by written examination his competency to plan, structurally design, and supervise the construction of buildings and similar structures. Each complete year of study in a registered school or college may be accepted in lieu of one year of experience; in this case, the applicant must submit evidence of sufficient additional experience to give him a total of eight years.

The examination in New York State is based on the four following subjects or groups:

**HISTORY OF ARCHITECTURE.** The candidate gives evidence in the examination, by means of clear descriptions, analyses of plan, construction, general expression, and ornament, that he understands the essentials that give character to the various historic styles of architecture.

**ARCHITECTURAL COMPOSITION.** The candidate must show that he understands the broad principles underlying the subject of architectural planning by the application of those principles to specific problems stated in the examination. The social, economic, and physical requirements of several architectural problems are outlined and the candidate is asked to state the principal considerations that would guide him in the choice of an arrangement of plan that would most adequately express and fulfill the conditions suggested.

**ARCHITECTURAL ENGINEERING.** In this subject the candidate's handling of the examination must give evidence that he has a thorough understanding of the appropriate use of the various materials used in buildings. He is required also to solve certain technical problems, such as the calculation of the proper economic dimensions of various structural members common to buildings in the several materials noted. The use of handbooks is permitted. Questions are asked relating to structural design, use of materials, heating and ventilating, electric equipment, plumbing and fire-protection equipment, and elevators.

**ARCHITECTURAL PRACTICE.** In the examination the candidate must give evidence that he understands the moral and legal responsibilities of the architect in the proper performance of his duties. He is required to outline or draft clauses of contracts and to show that he understands the major provisions of state, county, and municipal laws and ordinances and the way they affect the different classes of buildings. Questions under this heading will be asked relative to the following topics:

**BUSINESS AND PROFESSIONAL FUNCTIONS OF ARCHITECTS.** Professional relation of clients and contractors. Responsibilities of architects and methods of conducting their business.

**BUILDING LAWS.** State, county and municipal. Filing plans and specifications. Obtaining permits.

**CONTRACTS.** Drawings, specifications, and agreement, as essential parts of the customary contract between owner and builder. Provisions as to bids, letting contracts, requisitions, certificates, and payments.

**SPECIFICATIONS.** General conditions, purposes, and scope. Principles that should be observed in writing specifications.

**DRAWINGS.** Purposes, use, and limitations of preliminary drawings. Essentials that should be embodied in contract drawings.

**The architect's inspector** watches the men while they work and reports back to his office as to what is going on at the job day by day. If he is a practical and experienced construction man, his worth is appreciated on the job. His presence there is equal to that of an additional superintendent or engineer. He will be able to offer practical suggestions that will help toward making the job a happy place in which to work. No honest contractor objects to this sort of inspection or supervision on behalf of the architect or the owner. Some architects, however, send young draftsmen to the job to act as their inspectors, perhaps having them stop there only occasionally, if it is not a large job. As these young men have not had much to do with construction work, and as they do not keep in close contact with the work, they can merely act as messengers between the architect and the job. If they do just that much, the contractor's men are usually satisfied. The trouble is, a young man of this type may be overambitious and become a thorough nuisance in many ways; yet he must be treated courteously, even when he deserves rather to be thrown off the job.

Figure 4 shows a typical daily report as sent by an architect's inspector, employed full time at the job, to his home office. The contractor's superintendent daily sends to his office a somewhat similar report.

**Specification writing** involves a knowledge of the materials and methods of construction in detail and of the various customs that apply in all the trades. This implies that the specification writer must have experience in all these matters. Pretty sketches for the client and well-prepared working drawings for the contractor should be followed by specifications that are as complete as the work warrants. The specifications are what guide the whole work in regard to the quality of materials and workmanship and the relations between the many parties concerned with the job. Specifications are legal documents as well as technical treatises and should always be written with these facts in mind.

**A good specification** is written in the same sequence, generally speaking, as the trades commence work on the job, following the section devoted to the general conditions. Thus, the first work heading would be Demolition, Clearing Site, or Excavating, depending upon which of

| JOHN T. BARTHOLOMEW, ARCHITECT |  |
|--------------------------------|--|
| INSPECTOR'S DAILY REPORT       |  |
| JOB <u>Morgan Residence</u>    |  |
| WORK DAY <u>16</u>             | DATE <u>April 2, '45</u>   |
| GENERAL CONTRACTOR             | WORK   |
| 4 Supt. T. K.                  | Watch. Casp. Fore.   |
| 6 Bricklayers }                | S. & E. walls. To 2nd  |
| 4 Laborers }                   | floor tonight  |
| 3 "                            | Moving scaffolds   |
| 2 "                            | Grading rear lawn  |
| 4 Carpenters                   | N. & W. window frames  |
| 4 "                            | Started 2nd fl. beams  |
|                                |  |
|                                |  |
|                                |  |
|                                |  |
|                                |  |
| SUBCONTRACTORS                 | WORK   |
| 4 Plbg.                        | Roughing 1st floor   |
| 2 "                            |  |
| 3 Elect.                       | Leaders, 1st floor   |
| CAUSES OF DELAY                | Much water from storm yesterday. No pump on job - expect one tomorrow. |
| INFORMATION NEEDED             | Please send the revised 2nd floor plan <u>at once</u>                  |
| (Put Remarks on Other Side)    | SIGN <u>Wm. Smith</u>  |

FIG. 4.—An architect's inspector's report.

these would be appropriate in the particular case. Suitable headings for the rough and finish trades would follow. The so-called "mechanical trades," however, are generally placed at the end of the specification. These mechanical lines are plumbing, heating, electrical, elevator work, and other piping, wiring, and machinery work.

The specifications are theoretically supposed to take precedence over the plans, what is described in the specifications being used in place of a differing plan indication for the same item. Similarly, large-scale drawings take precedence over small-scale drawings; therefore, estimators should always study all the detail drawings that are supplied with the general plans. Specifications, contracts, and plans must all be studied with great care; often a single sentence in a specification or a contract, or a simple note or symbol on a plan will mean the loss of the profit on a job.

**Estimators** like a specification so arranged that they can follow its order in their own work and use the specification as a complete check on the items required. It must be said, however, that nearly all specifications show an overlapping of items, and the task has—unfairly, perhaps—devolved upon the estimator of seeing that every item is provided for in his estimate, whether the items are all specified or not, and also to straighten out any duplications in the specifications and see that nothing is duplicated in the estimate.

Contractors and estimators learn to beware of loose phrases in specifications, especially if they do not know the architect from previous experience with him. Someone has described specifications as an architect's dream, a contractor's nightmare, and a material man's dilemma. Such phrases as "to the satisfaction of the architect," "as directed," "in the opinion of the architect," "as approved by the architect," "if required," etc., depend for their meaning upon the character and the whim of the architect and his inspector on the job and are, therefore, obviously unfair to the contractor. The estimator is at a loss as to what prices to put on items so worded, because the architect does not specify just what is wanted.

Estimators should make a list of all vague wording found in specifications, especially if the indications are that their firm is to be awarded the contract, and then, if possible, should have a clarification put into the contract before it is signed. At least, they should have all such items discussed before the contract is signed, and notes kept of the clarifications.

**Grounds for Dispute.** Most of the disputes in connection with building work arise from the fact that too little care has been given to the writing of the specifications. These disputes often lead to expensive lawsuits and arbitrations, which, although final, are unsatisfactory to all parties. It ought to be the duty of the architect to take care that when

a contract is entered into no disappointment may ever occur as to how much work the builder has to perform, what is to be the quality of that work, and how much money the owner must pay for it.

### Exercises

1. Briefly, what are the functions of an architect?
2. Describe the work of an architect's office personnel.
3. Make a sketch plan of an imaginary architect's office.
4. What is a shop drawing? Name some types.
5. What are the four subjects or groups that the New York State architects' license law examination is based upon?
6. What is the general form and arrangement of a specification?
7. What lines of work are commonly referred to as the "mechanical trades"?
8. What is the order of precedence of specifications, general scale plans, and detail drawings?
9. What should an estimator do regarding vague phrases that he knows may bring disputes if they are not clarified?
10. What are four vague phrases often used in specifications?
11. Write at least 100 words of notes on the architect and his work, from one or two of the books listed in the Preface. Name the books used.

## CHAPTER IV

### THE CONTRACTOR

The term "contractor," as used in building work, generally refers to the man (or firm) who undertakes to construct a complete building or to make a complete alteration of an existing building for an owner. The chart in Fig. 1 shows this relationship. He is sometimes called the "general contractor" or the "builder," to distinguish him more clearly from the subcontractors. Subcontractors may be called contractors also, in their own special lines of work. Thus there are plumbing contractors, heating contractors, painting contractors, etc. Material men are occasionally referred to as contractors or subcontractors, too—mill-work contractors, hardware contractors, etc., for example.

**The Contractor's Duties.** The contractor (general contractor) organizes and is responsible for the entire job. He supplies the tools, equipment, and material for doing the work that is to be done by his own men and he makes subcontracts for the work that he does not intend to have done by his own men. He establishes the job office and provides the superintendent, job clerks, layout engineers, and watchmen. He usually has to obtain the building permits and to provide the temporary safeguards, temporary toilet facilities, and water supply. He builds the architect's office on the job (when one is called for) and on large operations he provides telephone service, heat, and water supply in it. The contractor pays all the bills and pay rolls for his own work on the job, and he also pays the subcontractors. He has to satisfy a great number of Federal, state, and local laws, which call for taxes and insurance of many kinds, and he must make the whole job comply with the requirements of labor department, building department, and other public inspectors.

The building business is romantic and challenging, but it becomes increasingly complex with the passing years. No longer can the bright young foreman blossom out into a contractor by merely having a sign painted with his name on it. At least, this is not one of the important steps. Now, he must first organize to suit many laws and regulations, union requirements, financial arrangements, etc. Modern contracting is a business to be learned well before one undertakes it. It is not a poker game where the inexperienced may think they can jump in occasionally and win. Sometimes even an experienced contractor errs in

thinking that he will be a wizard at anything he attempts. Only a small proportion of the men who start in business as contractors ever become really successful. Many of those who fail are expert mechanics, some are good foremen, and others are estimators who are lacking in experience. Perhaps the main reason for all failures is a lack of the understanding that the expert estimator possesses. Such an estimator is the logical man to start a building business; yet—by virtue of his deep insight into the many problems that are involved—he knows the importance of being organized for efficient management of every detail of the business, in addition to being strongly organized financially.

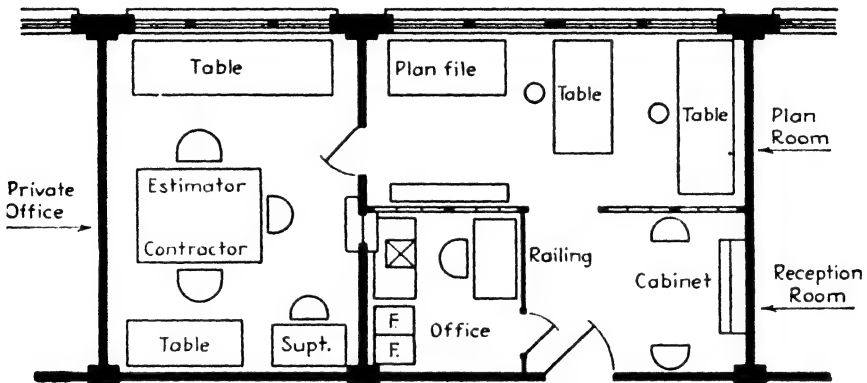


FIG. 5.—A contractor's office.

Figure 5 shows a plan of a typical contractor's office. The staff organization in such an office consists of the contractor, the estimator (or "office man"), the superintendent (or "outside man"), and the bookkeeper-stenographer. Where there is enough work, a regular bookkeeper and a timekeeper are employed. If the jobs handled are large enough in size, a superintendent is placed on each one and the so-called "outside man" becomes the general superintendent.

Obviously, hit-or-miss, slovenly ways of working should be avoided. Economy and savings usually follow in the wake of method and orderliness. In addition, the morale and interest of employees are raised by an atmosphere of order and method. Some men are peculiarly fitted for the planning and planting of construction work. Other men, who are deficient in this faculty, are capable of managing and executing plans. It almost goes without saying that unless a job is well planned and well planted, even the most conscientious management will all too frequently not be able to save it from loss. One is beaten from the start. Time could not be spent more wisely than in making a close study at the beginning to discover the best possible way of doing everything on the job. Construction men like clean-cut, decisive instructions, but only

with a well-thought-out program can such instruction be given with confidence.

A job is on comparatively safe ground when it is under the direction of a real superintendent, when it has a sensible but simple cost system, and when it has been properly planned and coordinated before being started. Good men cannot be held for such purposes in an organization, however, unless loyalty, ability, and earnest interest are rewarded. "Cheap" men are often very expensive in the end. A real superintendent is a man with experience, judgment, alertness, and a disdain for carping criticism. He is considerate and tactful in handling men, although he demands results from them. He avoids all favoritism. He is thick-skinned but always fair. He keeps informed as to new methods and equipment.

Jobs are affected by dissatisfaction among subcontractors. Too close bargaining or poor supervision on the job on the part of the general contractor's men may cause this. When a contractor holds the subs down to the last cent, things seldom go along as smoothly as they otherwise would. Bargains can be too close, and there is no tonic so stimulating to subs as making money. If they are squeezed too tight, by and by the general contractor himself gets squeezed, often in most unexpected ways. The law of compensation seems to bring this about.

**A progress schedule** should be made out for every job. This shows the dates for the starting and finishing of each branch of work. In this way, control is better and the work of the various trades is less likely to conflict. The foundation, the rough superstructure, and the work of the finishing trades are the three general divisions of the schedule. Each of these divisions is subdivided to include the work of every different group of men that will be required on the job. The progress schedule is made out by the contractor's estimator, after consultation with those subcontractors upon whose work the progress of the job will mainly depend. Copies of the schedule are given to the architect and to all the main subcontractors. The other subcontractors and material men are notified as to when they will be required. Figure 6 shows a typical progress schedule.

Cost records should show all the items on the job—at least, all those in any given main division—and not just a sample day's work or a single item of work. The cost books should preferably be made to balance, just as an accountant's ledgers are balanced and closed. In this way, the incidental costs of foremen, hoisting, handling materials, insurance, etc., will not be ignored. The final analysis of the job-cost records should be very carefully compared with the estimate and every possible lesson be learned from this comparison for future estimating. Figures 7, 8 and 9 present typical cost record sheets. Nothing quite takes the

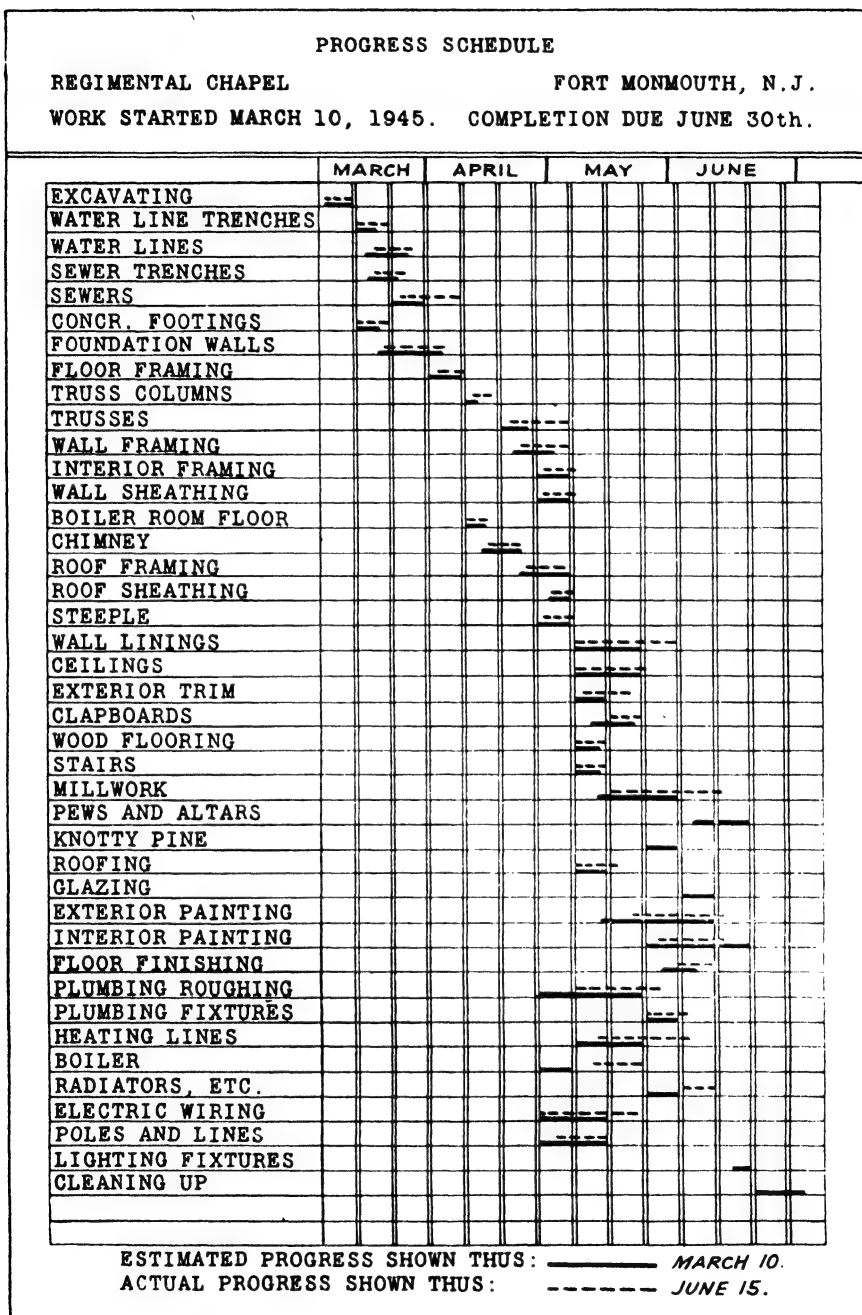


Fig. 6.—A progress schedule.

| COST RECORD  |                  | READY-MIX CONCRETE, PER CU. YD. |                            |
|--|------------------|---------------------------------|----------------------------|
| Cost of concrete foreman, concrete gang, runways, stacking materials, and insurances. Add cost of delivered concrete, admixtures and hoisting. |                  |                                 |                            |
| 1943   | Job              | Cost                            | Remarks                    |
| June   | Brenner res.     | 2 59                            | 12" fndn. walls            |
| Sept.  | Stewart Bldg.    | 2 81                            | 14" fndn. walls            |
| Oct.   | Do.              | 2 46                            | 6" floor on grade          |
| <u>1944</u>  |                  |                                 |                            |
| Jan.   | Dover Q. M. C.   | 3 14                            | 10" walls. Winter          |
| June   | Do               | 3 01                            | 7" reinf'd floor, screeded |
| Nov.   | Johnson res.     | 2 54                            | 12" fndn. walls            |
| <u>1945</u>  |                  |                                 |                            |
| Feb.   | Dover R. R. Sta. | 3 08                            | 16" fndus. Winter          |
| April  | Do               | 3 22                            | 6" reinf'd floor frame     |

FIG. 7.—A cost sheet for concrete work.

| COST RECORD  |                  | ROUGH FRAMING, PER MBF |    |                        |
|--|------------------|------------------------|----|------------------------|
| Cost of carpenter foreman, carpentry gang, handling and stacking, nails, and insurances. Add cost of delivered material and any special hoisting.. |                  |                        |    |                        |
| 1943   | Job              | Cost                   |    | Remarks                |
| June   | Brenner res.     | 62                     | 17 | Average, - all framing |
| Oct.   | Stewart Bldg.    | 60                     | 91 | Floors, 3x12           |
| Nov.   | Do.              | 80                     | 14 | Roof, 3x10, 3x8        |
| 1944   |                  |                        |    |                        |
| Feb.   | Dover Q. M. C.   | 74                     | 90 | Roof, 3x8, 10, 12      |
| July   | Johnson res.     | 61                     | 80 | Average, - all framing |
| 1945   |                  |                        |    |                        |
| March  | Dover R. R. Sta. | 77                     | 23 | Roof, 3x14             |

FIG. 8.—A cost sheet for carpentry.

31715

| COST RECORD   |                  | COMMON BRICK, PER M |                   |
|---|------------------|---------------------|-------------------|
| Cost of mason foreman, masons and laborers, handling and stacking, mixing mortar, and insurances. Add cost of all materials, scaffolds, cleaning, pointing, and hoisting. |                  |                     |                   |
| 1943  | Job              | Cost                | Remarks           |
| Oct. 1944   | Stewart Bldg.    | 30 15               | 8" & 12" back-up  |
| Jan.  | Dover Q. M. C.   | 38 37               | 12" walls, Winter |
| July  | Johnson res.     | 35 20               | Chimney           |
| Dec. 1945   | John's house     | 34 90               | Chimney           |
| Feb.  | Dover R. R. Sta. | 29 88               | 8" back-up        |
| Mar.  | Do.              | 37 12               | Chimney           |

FIG. 9.—A cost sheet for mason work.

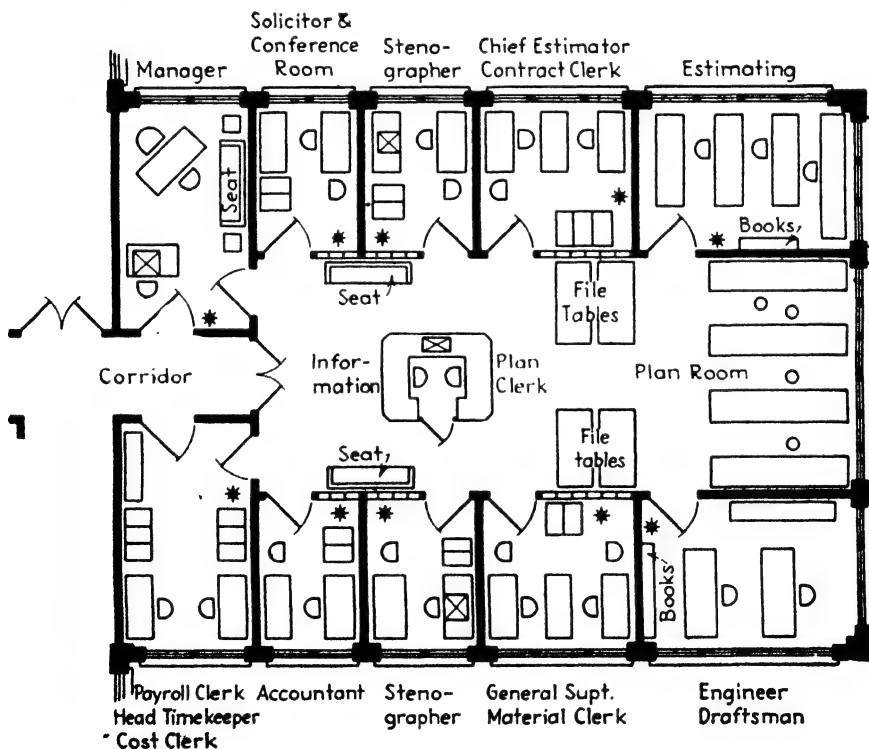


FIG. 10.—A construction company.

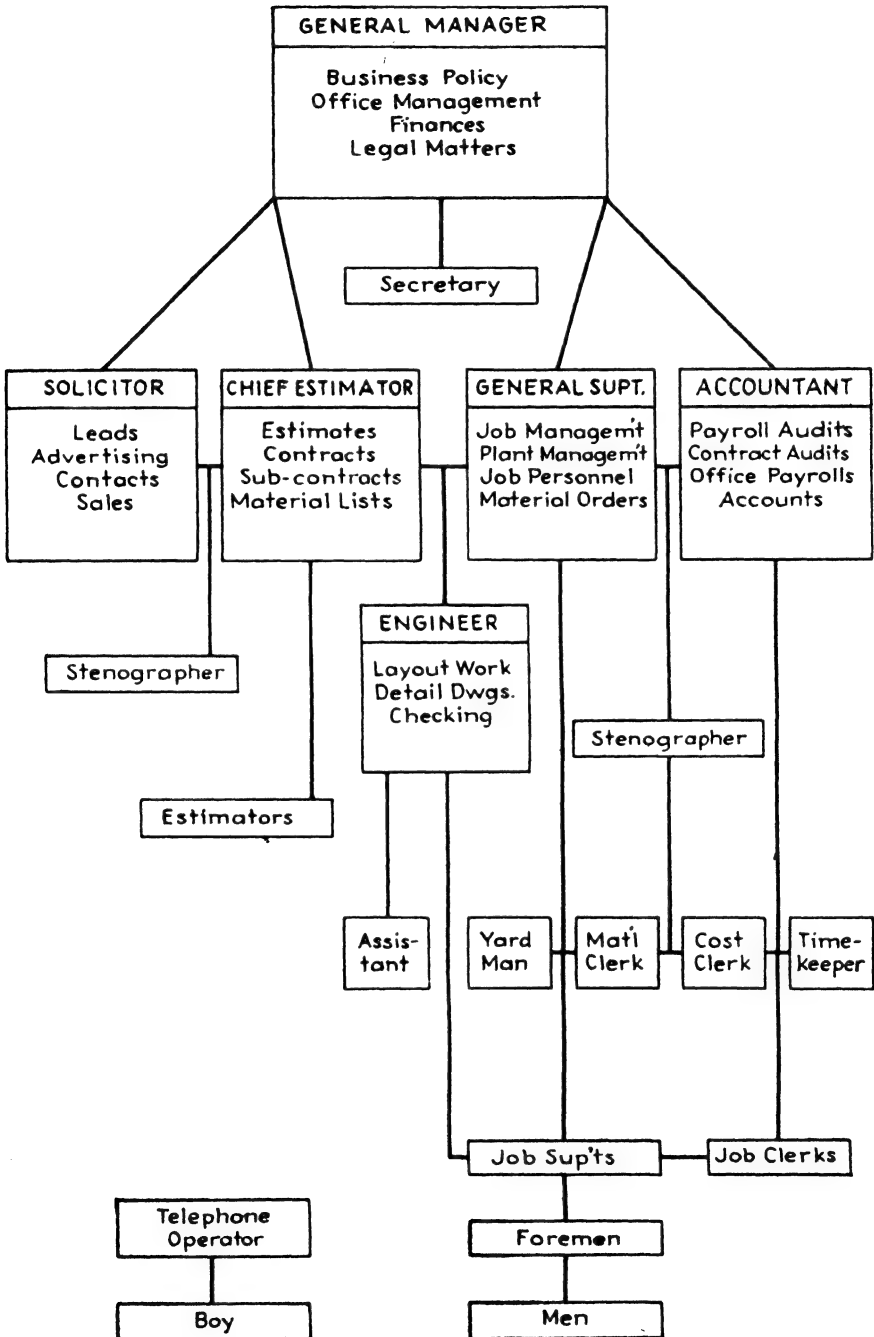


FIG. 11.—Organisation of a construction company.

place of one's own records when the matter of costs is concerned. Actual detailed accounts and analysis of work done under a contractor's own supervision give him a keen insight into the cost of the work performed that will develop in him (and in his estimator) the confidence required to estimate future items of the same kind.

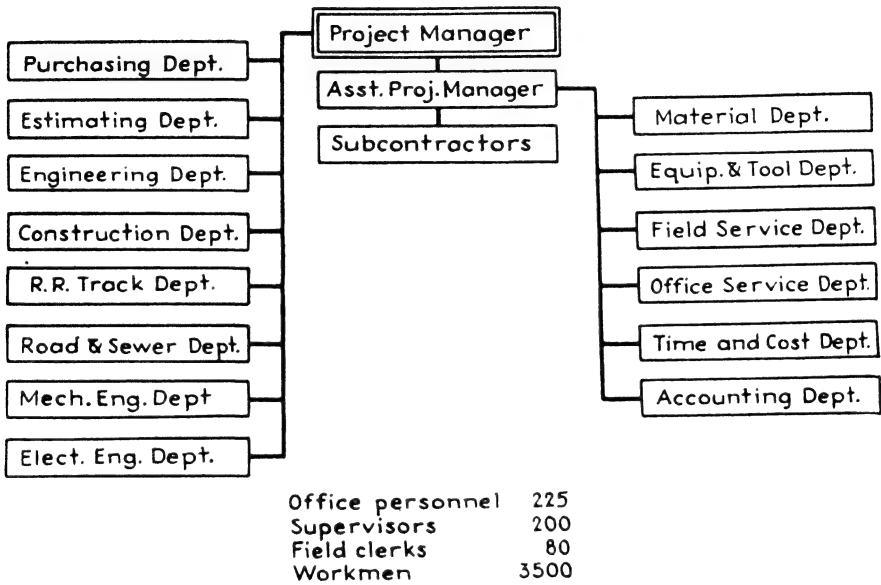


FIG. 12.— A large job organization.

The construction company is simply an enlargement of the building contractor. There are many varieties and sizes of these companies. Some are national or even international as to the territory in which they operate. Some offer to build any kind of structure, while others specialize in certain types of structures or in certain kinds of construction. Often they maintain complete designing and drafting departments and may go so far as to have financing departments, as well. A few companies have no workmen on their own pay rolls and sublet all the various lines to other contractors. A few, at the other extreme, have all the workmen on their own pay rolls and sublet nothing. The majority, however, do all the laying out and superintending and some of the work with their own men, besides. Figure 10 shows the plan of one construction company's home office. Figure 11 is the organization chart of the same company.

Very large operations are usually organized with full business facilities in the job office itself. The job office then becomes really a branch office of the company. Figure 12 shows the organization of a large and important job, employing about 4,000 men. Chapter XI, dealing with

the cost of job expense and office expense, contains detailed lists of the personnel in each department. A study of these charts will enable the student quickly to get a grasp on the business of contracting and an idea of the items that go into the general divisions carrying such names as Job Expense, Job Overhead, General Expense, and Office Expense.

**This chapter** has discussed points that are of interest to everybody concerned with building work. They are of interest to students of estimating because of their effect on estimates. The general contractor's own personality, training, and character are very important factors that must be kept in mind by the estimator. The contractor's personality has a psychological bearing on the office organization, on the job management, and on the subcontractors. His training, if it is thorough and practical with respect to building work, can be turned to advantage in a very beneficial way; but if it is not based upon practical experience, it must be seriously considered in connection with the pricing of estimates. His character, as is the case in that of any business man, is of prime importance. If he is honest and has a good reputation among his own personnel and among subcontractors and architects, then the whole work in the office and on the job runs along in a pleasant way, without undue friction. If he is of poor character, you would better get away from him as soon as possible, for fear of becoming contaminated. Character and reputation--both more valuable than many young men realize--can make for happiness if they are of the right sort. Keep your character and your reputation *clean*.

### Exercises

1. Briefly, what are the functions of a general contractor in connection with building work?
2. Make a sketch plan of an imaginary general building contractor's office.
3. What are the qualities of a good superintendent of construction?
4. Make a progress schedule for an imaginary job.
5. Name the departments that might be found in a highly organized job.
6. Write at least 300 words of notes on the contractor and the business of contracting, taken from two or three of the books listed in the Preface. Name the books used.

## CHAPTER V

### PLANS AND PLAN READING

**Blueprints** are copies of drawings that are made in a blueprinting establishment by a photographic process in which chemically treated white paper is exposed to a strong light. The tracing is placed over the sensitized paper, which turns blue where the light strikes it through the tracing, but remains white beneath the black lines and other markings on the tracing, which do not allow the light to pass through. The prints

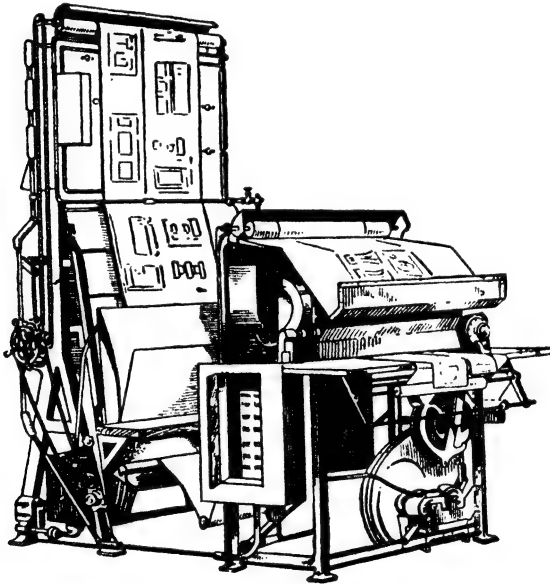


FIG. 13.—A blueprinting machine.

are the same size as the original drawing from which the tracing was made; thus, when anyone reads a blueprint, he is really reading the architect's drawing. As many prints as are desired can be made from one tracing. Usually, about eight sets of the regular plans are required to provide enough for the contractor's office, for the subcontractors, and for other purposes.

**Building plans** are generally understood to mean those that are prepared by the architect. These, together with the accompanying specifications, are intended to show or to describe all the work thoroughly.

What is not shown on the plans should be fully described in the specifications, and what is not described fully in the specifications should be plainly shown on the plans. In general, dimensions, shapes, and other items of information that can best be shown graphically are put on the plans. Long descriptions of the way the work is to be handled and other

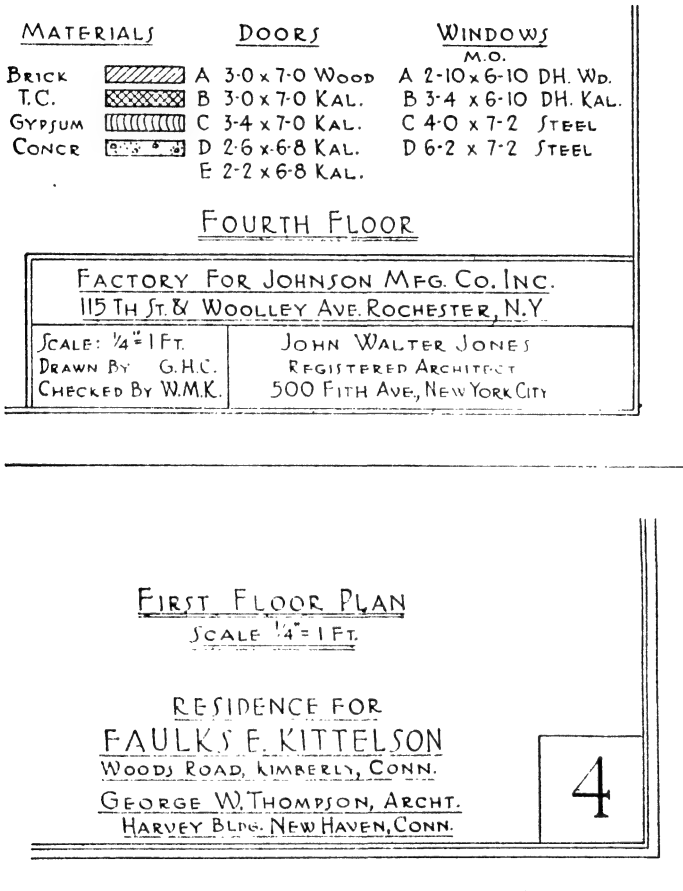


FIG. 14.—Title boxes, etc., on drawings.

matters that are best treated in written form are covered in the specifications. In some ways, the specifications are more important than the plans. Realizing this, a good architect takes as much care in the specification writing as he does in the preparation of the plans. Specification writing involves a detailed knowledge of the materials and methods of construction and of the various customs that apply in building work.

**Plan reading** involves specification reading as well, for, although plans may be complete in every respect, the materials to be used and the



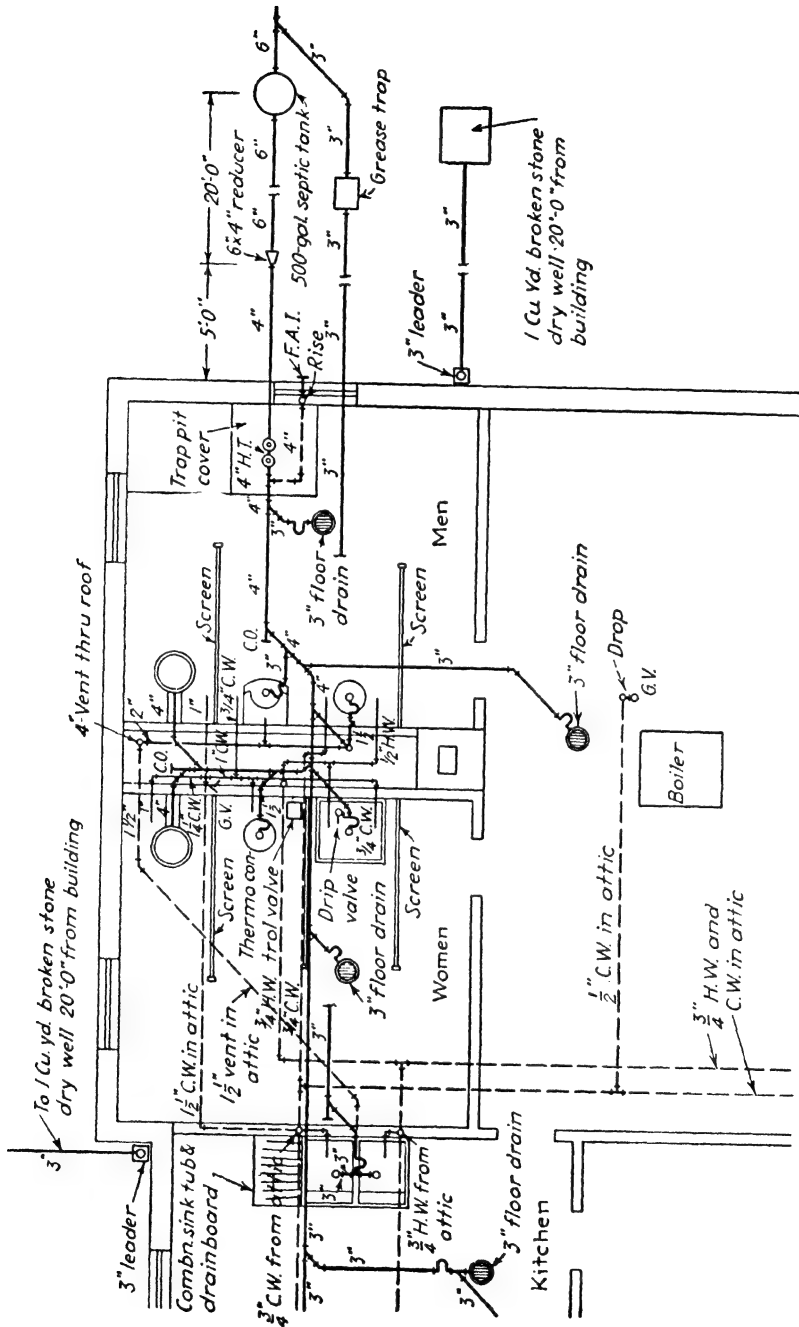


FIG. 16.—Portion of a mechanical plan.

workmanship desired are generally found only in the specifications. In order properly to understand what is shown on the plans, therefore, it is usually necessary to read the specifications, too. Even the plans and the specifications together do not give every little detail of building work. It is assumed that the builder knows how buildings are constructed and, for this reason, he and, of course, the estimator must have training in the practical use of plans and specifications. They should also have had considerable experience with actual building work of the general nature of that shown on the plans being used. Figures 17 to 25 comprise a complete set of architectural plans, except that the borders, titles, etc., have been omitted in order to make use of the entire area of the textbook page to show the drawings to better advantage. Figure 14 shows two typical title boxes, etc.

Besides architectural plans, sometimes separate structural plans and sometimes separate mechanical plans are furnished. Structural plans, or "framing plans," as they are often called, show the columns, girders, beams, and other framing members more clearly than they could be shown on the general architectural plans. These plans are used when the framework of the building is to be of the skeleton steel type or when the portions of the structure of the building are so complicated in design that a large amount of information is required on the plans. In like manner, mechanical plans are used when it is desired to show the plumbing, heating, and other branches of the mechanical equipment better than they could be represented on the regular plans. Special plans, such as these, may be prepared in the architect's own office or they may be made by outside engineers. The latter is usually the case when the special problems involved are very intricate and require the services of a specialist. Figure 15 shows a portion of a structural plan and Fig. 16, a portion of a mechanical plan.

The term "plans" is loosely used to refer to all the drawings, including not only floor plans but elevations, sections, and other drawings as well. Most building plans are drawn to the scale of a quarter inch to the foot. This means that every quarter inch measured on the plans represents one foot, or twelve inches, at the building. The scale rules are intended to save time in measuring the plans, although, of course, an ordinary rule can be used and the number of quarter inches measured can be counted. Other scales in common use for regular architectural drawings are  $\frac{1}{8}"$  to the foot and, especially for details,  $\frac{1}{2}"$ ,  $\frac{3}{4}"$ , and  $3"$  to the foot. Full-size and half full-size details are occasionally made for special features of buildings.

Some draftsmen have a bad habit of using several different scales in a single set of plans, where one scale could be used, or of using different scales for several drawings that appear on one sheet. They may even

indicate one scale in the corner of a sheet and then make all the work or part of the work on the sheet at a different scale. Estimators learn to be very careful and to apply the proper scale to each drawing separately, regardless of the scale that may have been indicated.

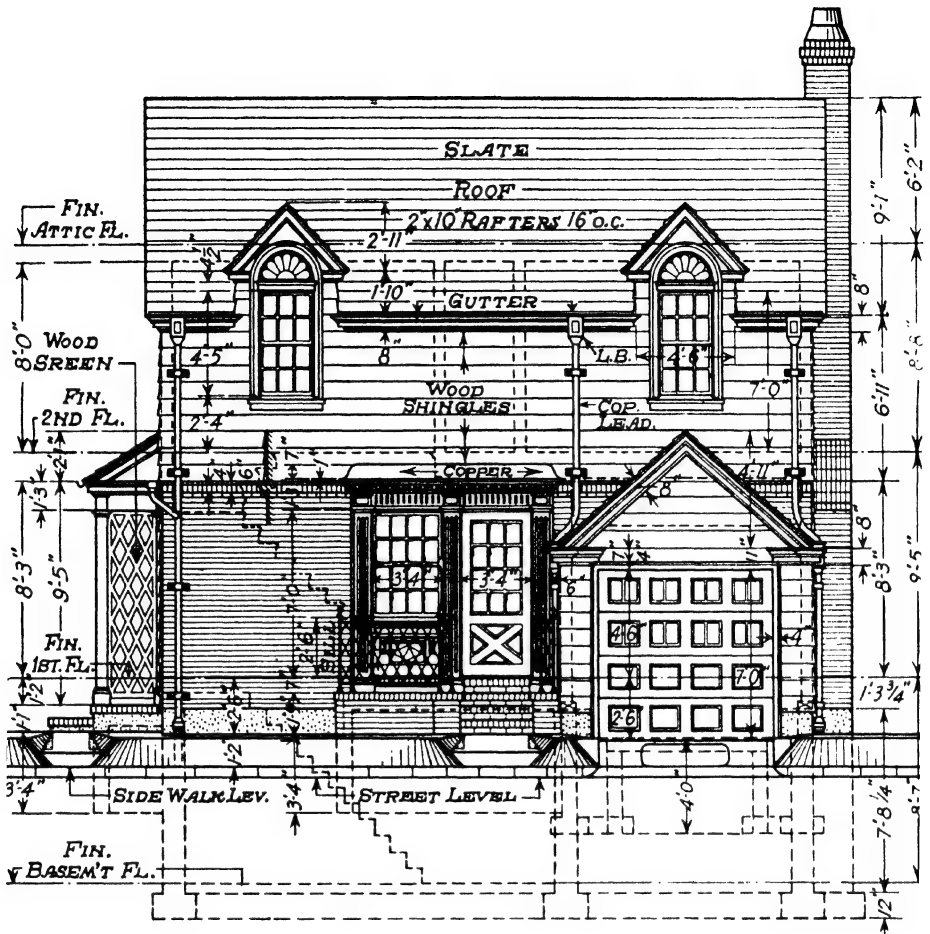
**Floor plans**, generally speaking, are pictures of the floors of buildings, such as one would get were he to imagine a building cut through on a horizontal plane, just above the window-sill level, and the upper part of the building removed. This view of the building shows the arrangement of the rooms and the location of the doorways, halls, stairs, etc.; and gives the thickness of the walls and partitions and the size of the various parts of the building as measured horizontally. In making a floor plan, the draftsman uses conventional symbols or ways of indicating objects. These conventional indications are fairly well established, but there is no law making it necessary for any particular form of indication to be used. It should be noted, also, that draftsmen take liberties, so to speak, and show on floor plans items that would not be seen in a strict interpretation of the floor plan as a picture. Electric ceiling outlets, wall brackets, and kitchen wall cabinets, for example, are practically always shown on the floor plans of a building. Other ceiling and wall features, also, are frequently included on floor plans. Figures 21, 22, and 23 are floor plans.

**Elevations** are views of the exterior of a building. The front elevation shows the outside of the front wall as one would see it when standing across the street. Note, however, that this is not a perspective or photographic view of the building. This is because the draftsman assumes that every point is directly opposite him or that he is always directly in front of every feature or point shown on the drawing. This is necessary in order that the drawing may be measured correctly with the scale rule. Figures 17 to 20 are elevations.

**Sections** show the interior of a building. A floor plan is really a section—a horizontal section, showing the floor layout, etc.—but the term “plan” is always applied in this case. Sectional views are those obtained by imagining a building cut through the other way—in a vertical plane, instead of a horizontal plane—with one section of it removed. The picture thus presented shows the various floors, one above another, and the roof at the top. It shows the thickness of the floors and the heights of the basement and other stories, as well as their relation to the ground level at the building. Figures 24 and 25 are sections.

**Detail drawings** are made of the parts of the building that require to be developed in this way in order that the exact construction or shape of the parts may be seen more readily. This is done when these details cannot be shown well enough on the regular plans or when they cannot be

*(Continued on page 50)*



# — FRONT ELEVATION —

— SCALE: 1/8" = 1'0" —

FIG. 17.

**Figures 17 to 25** comprise a complete set of plans for a house. **Figure 17** is a view of the front exterior, the "front elevation," as it is called. This shows the outside of the front, looking straight at every part. It is not the same as a perspective view. A perspective or photographic view would be taken from a single point and thus, even if one were to take such a view from directly in front of the house, some of the parts would be seen as partial side views. In an elevation all the parts are shown as though they were being looked at from directly in front.

This is a frame house having a portion of the front wall veneered with brick. The garage is a part of the house and can be entered from the main hall. The main roof slopes at somewhat the same angle as the garage roof, but the slope of the main roof cannot be shown in this drawing. By reference to the side elevations the slopes of the main roof may be seen.

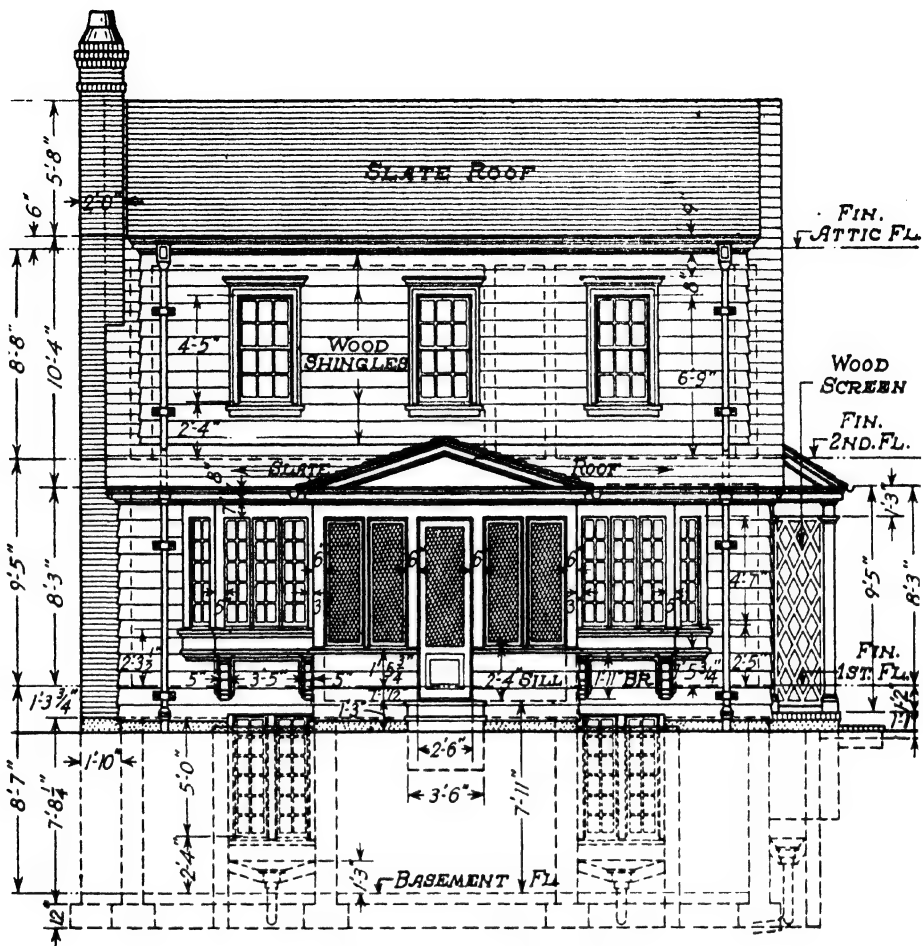
The garage door is of the "overhead" type, swinging up on tracks suspended below the ceiling of the garage. The garage floor is lower than the first floor of the house.

Note the raised platform at the front entrance, the covered side entrance with trellis, the stationary front window and flower box, and the two dormer windows. The 8'3" and 8'0" heights indicated at the left side are undoubtedly the ceiling heights of the first and second floors. The dormers, however, reduce the height of the second floor where they occur. The height from the second-floor level to the top of the dormer windows is shown to be only 6'9".

It is customary to show some of the subsurface construction on elevations in dotted lines, and here several of the foundation depths are shown.

#### Questions

1. With what materials is the front wall faced?
2. What is the roof-covering material?
3. How deep is the foundation for the front-entrance platform below the finish grade?
4. What are the size and spacing of the rafters?



# — REAR ELEVATION —

— SCALE: 1/8" = 1'-0" —

FIG. 18.

**The rear view**, or rear elevation, shows no brickwork except that in the chimney and the edging on the side porch and step. The chimney is not at the back or the front of the house, but it is seen from both these directions. It is, therefore, shown on both the front and the rear elevations.

The back porch is shown in this view. Fly screens and a screen door are shown here. The specifications call for the door to have an interchangeable storm sash and for storm sash to replace the window screens for winter use.

The rear cellar windows project up above the ground line and are sheltered above by the projecting bay windows. These cellar windows are regular double-hung windows and are much higher than most cellar windows. Apparently the owner of this house wants to use his cellar considerably and has ordered these windows in an effort to produce a more pleasing effect inside. Ordinary cellar windows are single sash hinged at the top or bottom. Perhaps it was these full-size windows that caused the architect to call the cellar of this house a basement. Technically it is a cellar. A basement is a story that projects more than halfway above the ground level.

The outline of the cellar walls is shown in dotted lines. There are footings under the cellar walls, but none under the areaway walls or under the side-entrance porch walls. The cellar extends under the back porch.

The rain leaders of the main roof run through the overhang or "shed roof" over the first story, where a gutter connects at each side to the lower leaders. All the roofs, including those of the porches, overhangs, garage, and dormers, are covered with slate shingles. Exercise 3 at the end of Chap. XIX describes the roofing and sheet metal work.

#### Questions

1. What are the ceiling heights of the cellar, first floor, and second floor?
2. What type of windows do those on the second floor appear to be?
3. How thick are the footings shown on this elevation?
4. How deep is the bottom of the footings below the finish first floor level?



**The east elevation** is one of the two side views of this particular house. Here the rear bay-window projection may be seen. The dotted lines below the bay window indicate that the walls of areaways for the cellar windows extend down to the cellar-wall footings. Sometimes areaways are called for to extend down only to below the sills of the cellar windows and the walls around them are likely to heave, owing to the frost action, and to break the area walls away from the main cellar walls. In the plans given here, all the main foundation walls and the areaway walls and porch-foundation walls are constructed of concrete and are all poured at the same time and bonded to one another.

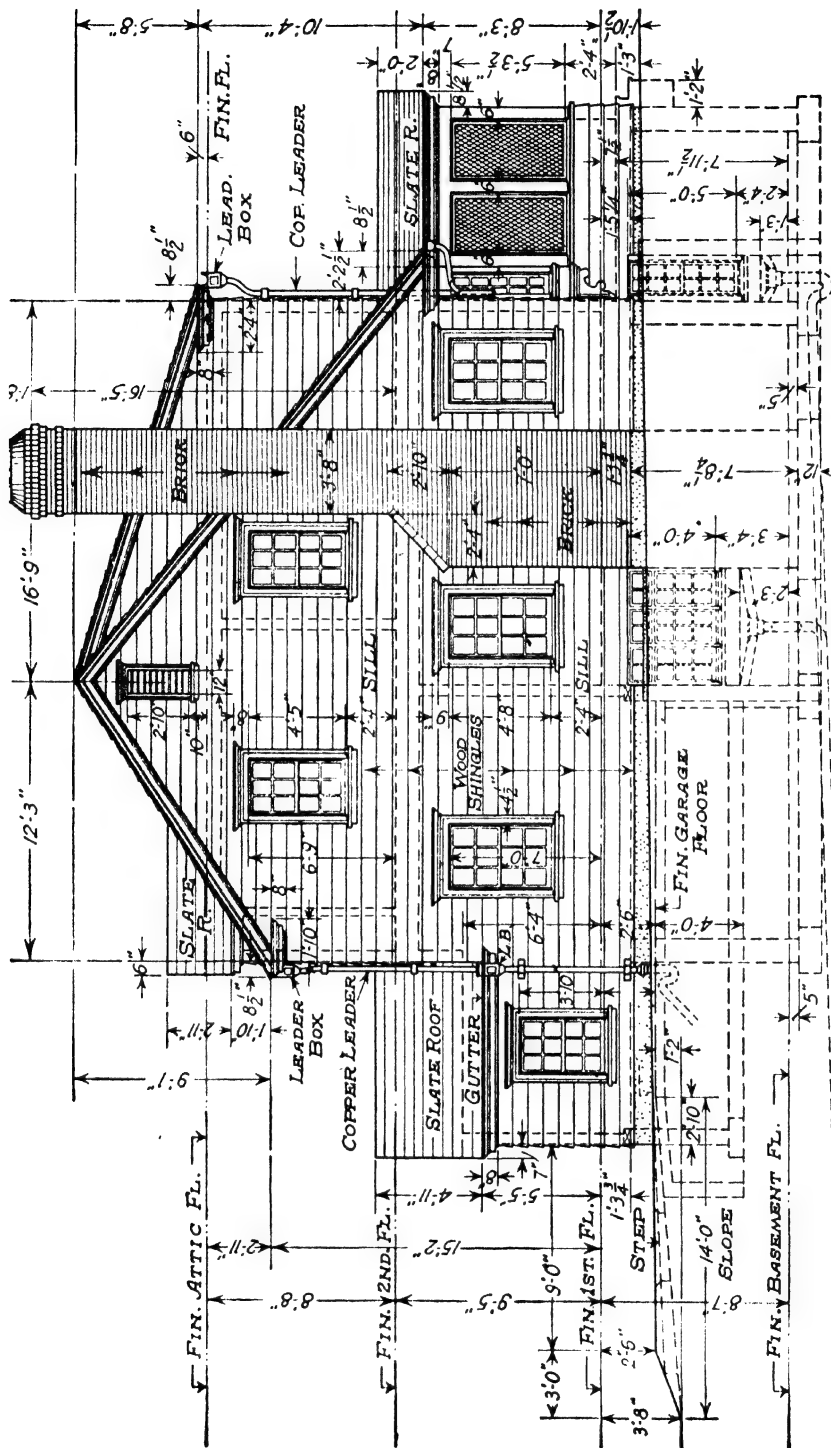
Apparently the present grade at the rear of the house is not to be changed, as it is shown coinciding with the finish grade. The specifications, however, may call for a certain amount of ground to be removed at this location and for topsoil to be installed for planting or for a lawn. The front ground is obviously too low at present and will require filling. This low area will provide a place in which to dispose of some of the material excavated from the cellar and thus save some of the expense of hauling material to the dump.

The kitchen window is different in size and shape from the other windows. The specifications call for a steel sash unit to be used in this opening, with a stationary sash in the middle and a casement sash at each side.

The opening at the top of the gable has stationary wood louvers for ventilation of the attic space. In this house the attic space has low headroom and is not intended to be used. This space is reached through a trap door in the ceiling of one of the second-floor closets.

### Questions

1. Using a scale rule, measure the extreme length of the house, including the garage and the rear porch.
2. Using the scale rule, measure the extreme height of the structure, from the bottom of the footings to the peak of the gable.
3. Using the scale rule, measure the depth of the house from the finish grade under the kitchen window to the cellar finish floor. The cellar finish floor is 5" above the top of the footings.
4. Using the scale rule, measure the height of the main rear wall above the finish grade shown on this drawing.



WEST SIDE ELEVATION.

SCALE: 1/8"=1'-0"

**FIG. 20.**

**The west elevation** shows the chimney side of the house. Here may be seen the other rear bay window and the side of the garage away from the main entrance to the house.

The garage does not end at the front wall of the main part of the house, as one might at first suppose, but extends into the house almost to the window immediately in front of the chimney. Note that the garage foundations do not extend down as far as the cellar walls. There is no cellar space under the garage. The walls do extend 4'0" below the finish garage-floor level, however, as this is the depth required for escaping frost action in most localities. Extending the areaway walls down 4'0" would not prevent frost action, because the inner faces of these walls are exposed down to the level of the area bottoms just below the cellar window sills.

The areaway walls project a few inches above the finish grade, forming a curb to prevent some of the rain water from entering the areaways.

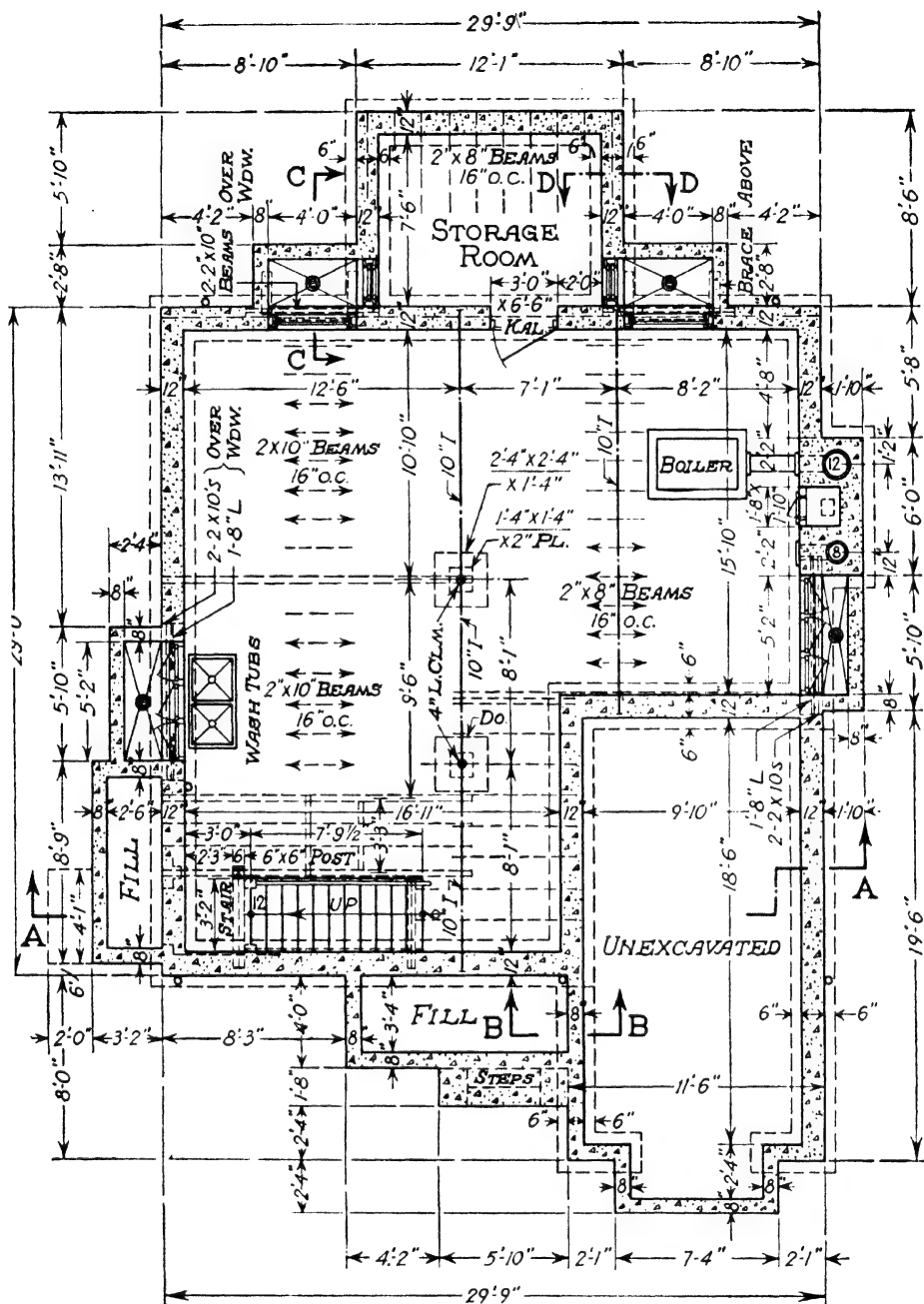
The chimney is wider at the bottom, in order to provide for the fireplace in the living room. One of the flues serves the fireplace and the other serves the boiler that heats the house and that is located in the cellar.

All the walls shown on this elevation, including the sides of the dormers and the rear porch, are frame walls covered with wood shingles.

The type of cellar window to be used is indicated on this drawing. These are to be casement and double-hung windows and not the more common top-hinged type. Section C-C in Fig. 25 shows an elevation and a section of these windows.

#### Questions

1. How many lights of glass are there in each window? In each sash?
2. How high is the chimney, from the top of the footing to the top of the chimney cap?
3. What is the difference in level between the sidewalk and the floor at the back of the garage?
4. What is the difference in level between the sidewalk and the finish cellar floor?



**— BASEMENT PLAN —**

— SCALE: 1/8" = 1'-0" —

FIG. 21.

**The cellar plan** shows concrete foundation walls. The dotted lines indicate the concrete footings under these walls and also under the two columns. Footings are wider than the members that they support, in order that the great load involved may be spread over a larger area in the ground. For tall buildings, where the loads are tremendous, it is necessary to plan the footings and the foundations with great care and even to test the bearing value of the ground.

This plan shows the main cellar and the cellar storage room under the rear porch. The spaces under the garage and under the front and side entrance platforms are to be filled in with dirt and to be well tamped to support the concrete slabs that are poured on top.

Note the indication of the sizes and spacing of the floor beams that are laid over the cellar to support the first floor.

### Questions

1. What material is used for the cellar and foundation walls? What thicknesses?
2. What is the total outside perimeter of the walls that extend down to the cellar floor?
3. What size and type of door is shown in the cellar?
4. How many steel columns and girders are there?
5. What is the size of the column footings?
6. What are the sizes and spacings of the first-floor beams?
7. How many square feet of cellar floor are there?
8. How many cubic yards of concrete are there in all the wall and chimney footings?
9. Draw a sketch plan of the cellar and foundations. Draw on it, with a colored pencil, the outline of the outside of the excavation required, allowing room outside the walls and the footings for the proper construction of them.



**The first-floor plan** shows many of the features already discussed, such as the garage, the main entrance, the side entrance, the rear porch and bay windows, and the cellar areaways. By keeping the elevations and the cellar-floor plan in mind, or by referring to them, one is better able to visualize these features on the first-floor plan. Plans and elevations should be carefully used in conjunction with one another at all times. Cross sections and detail drawings are often even more important in this way. Figures 24 and 25 are sections and details.

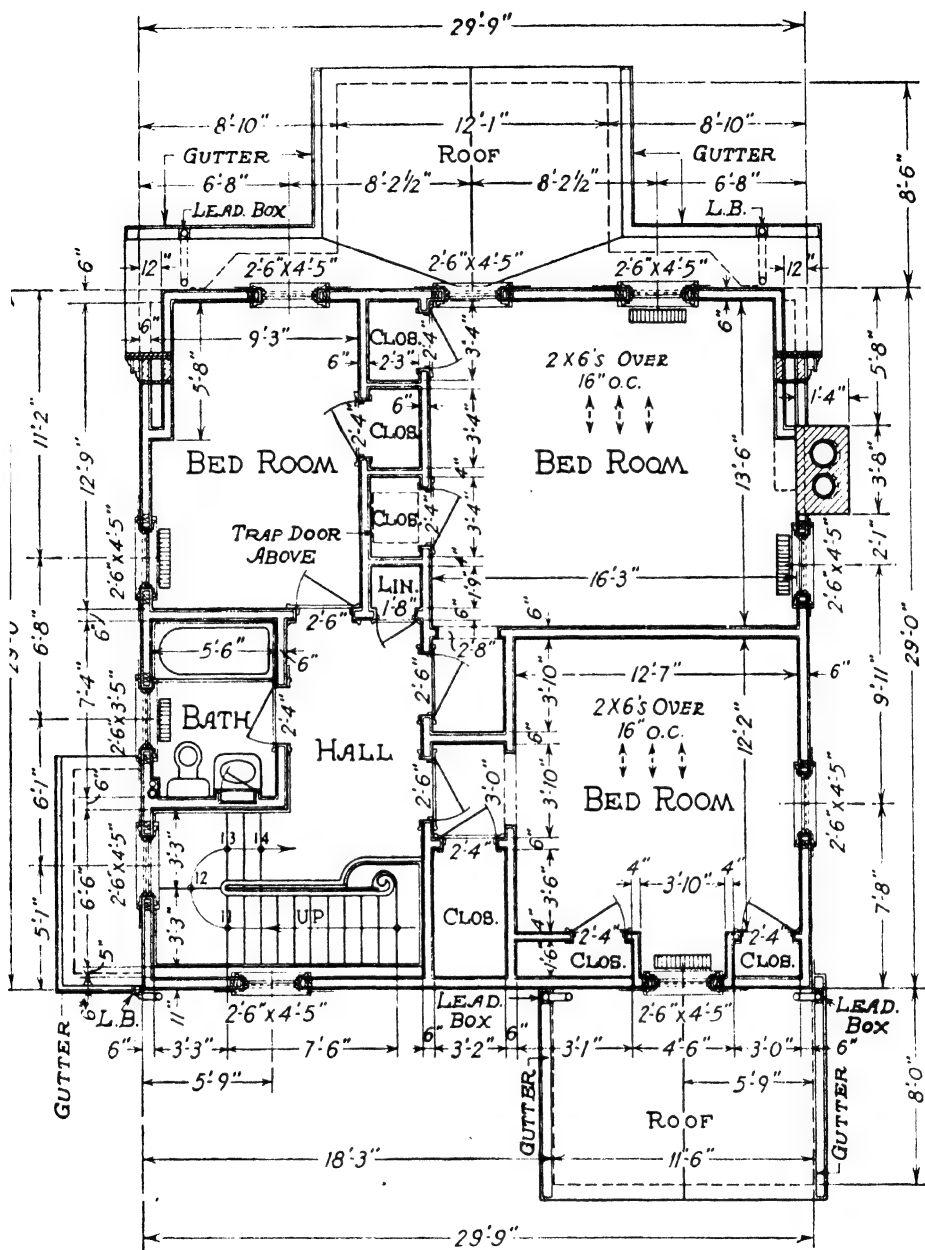
The scale at which all the elevations and plans for this house are drawn is  $\frac{1}{8}"$  to the foot. The cross section shown in Fig. 24 is also at  $\frac{1}{8}"$  to the foot, but the detail sections in Fig. 25 are  $\frac{1}{4}"$  to the foot. The two most common scales used for general drawings are  $\frac{1}{4}"$  and  $\frac{1}{8}"$  to the foot. Details are more commonly  $\frac{3}{4}"$  or  $1"$  to the foot.

This house is very compactly designed. Note the storage rack hung from the high portion of the garage ceiling. There is no waste hall space and even the sloping roof at the front of the house is taken advantage of for the stairway to the second floor. It is an economical plan, although there is no sense of spaciousness about it.

Kalamein doors close off the garage and the cellar from the main part of the house. Both the garage and the cellar stairway are covered with metal lath and cement plaster as a further protection against the spread of fire.

### Questions

1. Of what materials are the outside platforms made, and what are the dimensions of these platforms?
2. Describe the front-entrance doorway—items, sizes, etc. Refer also to Section B-B in Fig. 25.
3. Describe the floor beams of the second floor—sizes, spacing, etc.
4. Describe the kitchen—doors, windows, fixtures, sizes, etc.
5. What are the exact dimensions inside the three rooms, between finished walls and partitions?
6. What is the total area of the subflooring on the first floor? Adding 28 per cent for waste, how many square feet (board feet) would have to be ordered?



— SECOND FLOOR PLAN —

— SCALE:  $\frac{1}{8}" = 1'-0"$  —

FIG. 23.

**The second-floor plan** shows the layout of the three bedrooms, the bathroom, and the closets; also, the sloping roofs over the projecting portions of the first story, such as the garage and the side and rear porches. Only a few dimensions are required on this plan, as many of the first-floor measurements carry through to the second floor.

The section reference lines, such as A-A on this plan, refer to the sections given in Figs. 24 and 25.

The beams over the second floor are only  $2'' \times 6''$  in cross section, as they serve mainly for ceiling beams and for tie beams. The beams over the first floor are shown on the first-floor plan to be  $2'' \times 10''$  and  $2'' \times 12''$ . The floor beams over the living room are  $12''$  deep, because they span about 17 feet of clear space and would deflect and cause the plaster ceiling of the living room to crack if they were any less in depth. As a further precaution, they are called for to be spaced only  $12''$  apart, center to center, instead of the more customary spacing of  $16''$  on centers.

Note the way that the different parts of the building are shown on the plans. The walls and partitions are represented by two parallel lines scaling about  $6''$  apart. The walls shown on this plan are constructed of  $2'' \times 4''$  studs, covered on the outside with insulating sheathing board and wood shingles and on the inside by plasterboard and plaster, the whole thickness being about  $6''$ . The  $4''$  studs actually measure only  $3\frac{3}{4}''$ . The partitions are constructed of  $2'' \times 4''$  studs covered on both sides with plasterboard and plaster. The studs between the closets are turned "on the flat," to gain  $6''$  of space divided among the four closets between the two rear bedrooms. Note the way that the doors swing and refer to Fig. 120 in Chap. XVII for a diagram that gives the "hand" of doors.

Estimators do not like plans that are drawn at so small a scale as  $\frac{1}{8}''$  to the foot, because this does not allow enough room for showing all the important details, and they thus are forced to rely on the specifications, which, in turn, may not be very clear. Some architects always use  $\frac{1}{8}''$  for all the regular plans and elevations, but give, besides, a large number of detail drawings that show every important feature.

### Questions

1. Describe the bathroom—door, window, fixtures, etc., as shown on the second-floor plan only.
2. How many linear feet of baseboard are there in the three bedrooms, each one separately? How many square yards of plaster ceilings are there in the three bedrooms?



**Section A-A** is a view of the interior of the house taken through the front portion and looking toward the back. The reference lines A-A on the floor plans show just where the section drawing applies.

The entire stairway is shown. The inner construction of the house is seen, as well as the relation between the ground and floor levels.

Section views are of great value to the estimator and to the superintendent of construction, because they show so many of the construction features on one drawing.

The side-entrance platform is two steps below the first-floor level, as there is a step in the entrance doorway and another step under the kalamein door between the landing at the top of the cellar stairs and the first floor. The side entrance has a Dutch door, one in which the upper half may be opened while the lower half remains closed.

### Questions

1. How many risers are there in the entire stairway from the cellar floor to the second floor, including those from the landings?
2. How high is the lowest headroom under the stairway?
3. How high is the ridge of the roof above the top of the attic-space floor beams?
4. How long are the Lally columns?
5. Allowing  $7\frac{1}{2}$ " for each riser, how many risers are required between the first floor and the second floor? If the answer does not work out evenly with the total rise, what would you do about the difference?
6. Beams of what size are used over the back portion of the garage?
7. How should the storage rack in the garage be constructed and how should it be supported?

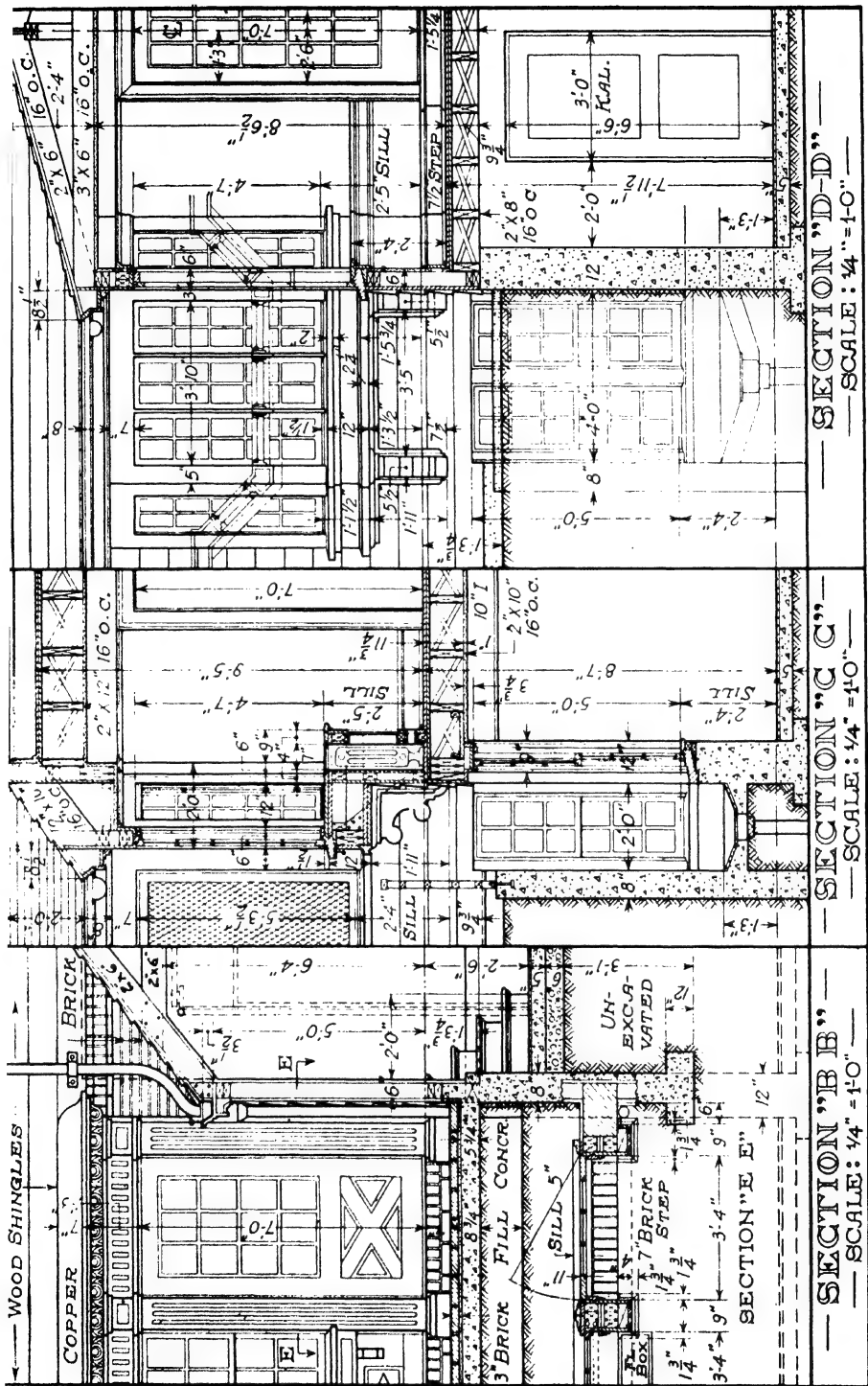


Fig. 25.

**The three sections** given in Fig. 25 show details of the construction at the front entrance, bay windows, cellar windows, and rear porch. These are features which are not found in every house and, therefore, require detailing.

The sections may be referred to as "details," although details are generally made at larger scale, sometimes being of full size. These are drawn at a scale of  $\frac{1}{4}"$  to the foot.

The construction of the garage roof is shown in Section B-B. It is not good practice to carry brickwork on wood framing, so a steel angle is inserted under the small triangle of brick veneer on which the brickwork is built. The storage rack in the garage occurs only under the high-ceiling portion of the garage, under the second-floor beams.

Section C-C is taken through one of the rear bay windows and the cellar window under it. Cellar windows are often set higher than these in order to admit the maximum amount of daylight into the cellar, the beams of the first floor being "framed out" to provide a space at each window. The floor over these spaces is carried on  $2" \times 4"$  beams.

Section D-D shows the construction of the rear porch. It has a wood floor carried on  $2" \times 8"$  beams. The cross bridging shown between these beams is employed also elsewhere throughout the house.

### Questions

1. How thick are the foundation walls of the garage, the house, and the areaways?
2. Beams and rafters of what size are used over the front portion of the garage?
3. Referring to all the plans, how many square feet of brickwork are there in the front-wall veneer? Allowing 7 bricks per square foot, how many bricks are required?
4. Using all the elevations and sections, list all the dimensions of the roof surfaces that are to be covered with slate shingles and compute the total area in square feet.
5. List all the rooms except the kitchen and porch and show the square feet of finish wood flooring required in each. Add 38 per cent to the total, for waste, and mark the answer "board feet."

readily described in the specifications. Details are thus made of doors, windows, cabinetwork, cornices, etc., when these are to be made up specially instead of in stock patterns. Special details of floor construction and of decorative work are often furnished along with the regular plans or are made up afterward. Figure 25 could be called a "sheet of details," but the illustrations in Chaps. X through XXIV are more truly detail drawings.

**Symbols** are used on plans to save time in making the plans and in reading them. Unfortunately, like the conventional ways of indicating materials, etc., they are not absolutely established as to use. Good architects do indicate brickwork, terra cotta blocks, and other regularly used forms of construction by crosshatching lines that are all but accepted as the standard method of indicating them. Doors, casements, and double-hung windows are generally shown on plans in such ways that persons familiar with plan reading seldom have trouble in discovering what is intended. National trade associations have endeavored to standardize the electrical and plumbing symbols. Despite all this, however, the estimator and all other men using plans have to be careful not to jump to conclusions regarding the symbols and other indications that they see on plans. What seems to be meant for gypsum blocks may mean terra cotta, instead; and what looks like brickwork may be concrete—just to mention two examples. Figure 14 shows a typical key to the symbols used on a plan.

**Abbreviations** are used to a considerable extent on plans and less frequently in specifications. There is usually no difficulty about them, although at times it is hard to interpret some of them, and there are often two possible meanings that could be applied to one abbreviation. It is recommended that as few as possible be used and that those that are used be made plain to understand. Specifications should describe all work fully, without any except the most common abbreviations, in order that disputes may be minimized.

**Laws and Regulations.** There are many laws and regulations pertaining to building work. The national labor laws and the social-security and old-age pension laws have to be considered, both in the preparation of estimates and in the actual work of erection of buildings. State laws very directly affect the design and construction of buildings and the use of buildings after they have been completed. A thorough study of the state labor laws and the local building code would constitute an excellent review of the whole field of building design, materials, methods of construction, and the proper care and use of buildings of all kinds. However, an understanding of the more involved parts of these laws can be gained only by means of a background of technical training and experience in building work. Union regulations are becoming more definite and

understandable, and these, also will have to be considered by the estimator.

Building codes originated in the desire of people for fire protection. Later, safety of life and health was looked for and the present-day codes cover the design, construction, equipment, and occupancy of structures of all kinds. Codes are intended to be schedules of minimum requirements and should never be used as specifications of good design and construction. In many instances, they certainly fall far short of describing the best.

A building code is a technical treatise on a highly involved subject and is not readily understandable by the layman. The purpose of the New York City code, as stated in it, is to provide standards, provisions, and requirements for safe design, methods of construction, and sufficiency of materials in structures, and to regulate the equipment, use, and occupancy of all structures and premises. It deals with the heating and ventilating of buildings. Stairways and other means of egress are given consideration. The important subject of sanitation is treated in a separate section, and fire-resistive construction, fire sprinklers, and standpipes for fire fighting are provided for. Elevators, in which many thousands of people travel every day, are governed by what is probably the longest and most elaborate set of elevator regulations ever produced anywhere.

Codes usually give definitions of the terms used in them. One should keep in mind that the use of terms in a code is not always the same as that in trade language, or the same as among real estate dealers and others having to do with property. For example, the terms "basement," "cellar," "fire wall," "penthouse," and others given in the code may have different meanings if used in other connections.

Some terms defined in the New York code are the following:

**enclosure wall.** An exterior nonbearing wall in skeleton construction, anchored to columns, piers, or floors, but not necessarily built between columns or piers, nor wholly supported at each story.

**curtain wall.** A nonbearing wall built between piers or columns for the enclosure of the structure, but not supported at each story.

**panel wall.** A nonbearing wall in skeleton construction built between columns or piers and wholly supported at each story.

**apron wall.** That portion of a panel wall between the window sill and the support of the panel wall.

**spandrel wall.** That part of a panel wall above the window sill and below the apron wall.

**parapet wall.** That portion of a wall extending above the roof.

**fire wall.** A wall provided primarily for the purpose of resisting the passage of fire from one area of a structure to another, and having a fire-resistive rating of at least four hours.

**partition.** A nonbearing interior wall one story or less in height.

**fire partition.** A partition provided for the purpose of protecting life by furnishing an area of exit or refuge, and having a fire-resistive rating of at least three hours.

**fireproof partition.** A partition other than a fire partition, provided for the purpose of restricting the spread of fire and having a resistive rating of at least one hour.

**fire door.** A door and its assembly capable of resisting fire, as specified in the code in detail.

**fire window.** A window with its sash and glazing having a fire-resistive rating of three-quarters of an hour.

**protective assembly.** An opening protective including its surrounding frame, casings, and hardware.

**floor area.** Any floor space within a story of a structure enclosed on all sides by either exterior walls, fire walls, or fire partitions.

**horizontal exit.** The connection of any two floor areas, whether in the same structure or not, by means of a vestibule or an open-air balcony or bridge, or through a fire partition or fire wall.

**place of assembly.** A room or space 2,500 square feet or more in area, or a space capable of or designed for containing 250 or more occupants and used for educational, recreational, or amusement purposes.

**private dwelling.** A structure occupied exclusively for residential purposes by not more than two families.

**human occupancy.** The use of any space or spaces in which any human does, or is required to live, work or remain for continuous periods of two hours or more.

**steel joist.** Any approved form of open-webbed beam or truss less than 20'' in depth, made from rolled- or pressed-steel shapes by welding, pressing, riveting, or expanding.

**controlled concrete.** Concrete for which preliminary tests of the materials are made and the water-cement ratio is made to correspond to these and other tests. All controlled concrete work must be inspected by the architect or engineer responsible for its design and a complete progress record kept.

**average concrete.** Concrete for which the preliminary tests are omitted and the work is without the inspection required for controlled concrete. When concrete structures are designed to receive their full loads at periods of less than 28 days after the concrete is installed, controlled concrete must be used.

**shaft.** A series of floor openings, consisting of two or more openings in successive floors, or a floor and a roof, shall be deemed a shaft and shall be enclosed. Such shafts shall be constructed of materials of three-hour rating, except dumb-waiter shafts and except vent shafts in nonfireproof residence buildings.

### Exercises

5-

1. Briefly, what is each of the following?

- a. A floor plan
- b. An elevation
- c. A section
- d. A detail drawing

2. What do the following abbreviations usually stand for?
  - a. Bldg. Line
  - b. T.C.
  - c. Fin.Flr.
  - d. Kal.
  - e. Brk.
  - f. D.H.
3. Describe briefly architectural, structural, and mechanical plans, and state what each shows.
4. What are blueprints?
5. Give three types of crosshatching used on plans, and state after each what it may be used to represent.
6. Give three symbols used on plans, and state after each what it may be used to represent.
7. What is meant by  $\frac{1}{4}"$  scale? Give an example of its use.
8. Makes sketches of a plan, two elevations, and two sections of a small private garage, with all the main dimensions.
9. Make a sketch plan of a grocery store, using a full page, and show the things listed below as they are generally shown on floor plans:
  - a. Brick exterior walls
  - b. Toilet room, enclosed with T.C. partitions
  - c. Show windows, counters, shelves
  - d. Doors, D.H. windows
  - e. Plumbing fixtures, electric lights
10. Write at least 300 words of notes on plans and plan reading, taken from two or three of the books listed in the Preface. Name the books used.

## CHAPTER VI

### CONTRACTS

**A contract** is an agreement between two or more parties. It must be properly made and must be for a legal purpose. It should be so clearly written that it merely forms the record of what is agreed upon between the parties and, therefore, can be filed away as soon as it is signed. This means that the contracting parties understand so well what is expected of them that no further reference to the contract should become necessary during the construction of the job. A contract should not review in detail items of material, workmanship, etc., that are already covered by the plans and specifications. It is merely the memorandum of the terms of the agreement between the parties that sign it. Because the contract may finally be interpreted in a court, it must be written in such form that it will be readily understood and have strength legally. A standard, printed short form of contract should be used where possible, and all the specifications and drawings should be properly identified by definite reference in the contract.

One form of contract provides for the contractor to furnish merely the services of his business organization to manage the construction work. This may be called the "management" type of contract. Under this form, the owner uses these services in much the same way as he would the services of a person whom he might employ and place on his own pay roll. The contractor is the manager employed by the owner for the particular job mentioned in the contract. The contractor's responsibility is to run the job entirely for the owner's interests—if there is no guaranteed limit of cost involved.

**The management type** of contract is used also in cases where the owner wants a guarantee as to the cost of the job. Here the contractor has a vital interest in the cost. He makes an estimate beforehand, upon the basis of information sufficient to enable him to do so; then, if changes are made in the information or in the amount of work to be done, a revision in the amount of the guaranteed cost becomes necessary. The contractor's compensation under the management type of contract may be a flat fee or it may be a percentage of the cost, as agreed upon when the contract is being written. This is then stated in the contract.

Another form of contract provides that the contractor shall furnish all materials, labor, and expense at unit prices that have been agreed

upon. This is like buying an order of groceries; each item is priced per unit of measure. As the work progresses, it is measured and the contractor is paid at the prices stipulated in the contract. If any new features of construction are introduced, new prices are arranged for them as they appear.

**The lump-sum form of contract** is the one most commonly used. In it the contractor agrees to construct the job complete, in accordance with the plans and specifications, for a definite sum of money. The plans and specifications should be as clear-cut as possible, so as to minimize the chances of any changes becoming necessary. If changes are made, they should immediately be estimated upon by the contractor and a supplemental contract should be made to cover them, before any work on the changes is started.

In the lump-sum form, the architect and the owner are not directly concerned with the details of quantities of materials and labor, unit costs, etc. In the management form of contract, without guarantee of cost, the contractor has every incentive to work in close conjunction with the architect and the owner toward completing the job with the best materials and workmanship and in the shortest time, and it is possible for the work to proceed before the plans and specifications are completed.

In any form of contract in which the contractor is limited as to the amount that the job is to cost, it is natural for him to use every reasonable method to economize in both materials and workmanship. This economizing is very likely to extend through to the subcontractors and material men, as well.

As has been stated before, what the owner primarily buys when a construction contract is signed is the contractor's skill and the use of his business and technical organization. Regardless of his ability to secure contracts, a builder without proper skill and a proper business and technical organization is operating under a very great handicap.

**Financing Contracts.** Some contracts provide that the contractor shall pay all his bills every month before asking for a payment from the owner to cover them. Thus, if a contractor has 10 jobs under way at one time and they average an expense for one month of \$25,000 each, he would have to pay out \$250,000 before sending in his bills to the various architects for approval. Then, before he received his payments from the owners, another half month would go by and he would have about \$375,000 outstanding. On this basis, the contractor would have to be a very wealthy man or else he would be in the banking business to a greater extent than in the contracting business. It is, therefore, part of the estimator's duties to warn the contractor against accepting contracts with such extreme wording regarding the method of making payments. If it is necessary to accept such a contract, the means of financing the

undertaking should be worked out before the contract is signed, and proper interest and service charges should be included in the contract amount to take care of the unusual financing requirements. The more customary procedure is for the contractor to pay his bills immediately after receiving payments from the owner and, if necessary, to submit proof to the architect or the owner that he has actually paid these bills before his next payment is approved by the architect.

On an average job costing \$500,000 and extending six months, the amount held back in the customary 15% that is retained is a large sum, as will be seen from the following table for such a job.

| Month | Amount done | 15% withheld |
|-------|-------------|--------------|
| 1     | \$ 18,000   | \$ 2,700     |
| 2     | 55,000      | 8,250        |
| 3     | 110,000     | 16,500       |
| 4     | 245,000     | 36,750       |
| 5     | 420,000     | 63,000       |
| 6     | 500,000     | 75,000       |

By the time the fifth payment is made, and only about \$40,000 of work remains to be done, the amount being withheld is about \$70,000. Thus, instead of 15%, there is 175% being withheld, based upon the amount of work yet to be done.

The 15% is often referred to as the contractor's profit. It really represents the cost of his office rent, the salaries of his estimators and general superintendent, general office salaries, and expenses. The salaries have to be paid every week, and the many other items involved, at least every month. Then, whatever may be left is profit! It might be better if contractors would write out their bills to show general expense and office overhead and profit separately; the profit item would be only 2% or 3% instead of 15%.

The percentages and the time of payments often require thought on the part of the estimator. In some cases it may be necessary to refuse to figure a job or to accept a contract unless better terms of payment are offered. Architects seem to be forever guarding against overpayments to the contractors. Very few of them are good businessmen, and this fact may account for their fear of granting more liberal terms. Contracts should be worded definitely as to how long the contractor must wait for each monthly payment. If 20 or more days are to elapse, he will not receive one payment until it is nearly time to apply for another. Meanwhile, his pay rolls have had to be met every week with cash. Inasmuch as the partial payments are based on estimates of the work done and not on detail measurements, it should be possible for the con-

tractor to submit requisitions three or four days before the end of the month and to expect these to be checked through so that he will receive payment by the fifth day of the following month, instead of having to wait several weeks, as is often the case.

**Arbitration** should be an important factor in contractual relationships. This method of settling disputes chooses men who are familiar with the practical work and problems of building construction to take the place of courts and lawyers, who are likely to be all tangled up in legal technicalities and very often are blind in their judgment, because they have not such practical knowledge. Estimators would do well to insist that an arbitration clause be provided in every contract. By this method, usually three men are chosen to settle any dispute arising out of the contract or plans or specifications. Each party to the contract selects one man and these two select a third. Each side presents its case to this three-man board and, when two of the three agree on a basis for settlement of the dispute, the matter is ended (thus it should be stated in the contract) and their decision is binding on both parties to the contract. One of the main advantages of arbitration is that either party has the right to ask for an arbitration any time it wishes. Thus, disputes may be quickly settled while the matters are still fresh in the minds of those familiar with the trouble. Law cases have a habit of dragging out into months and even years, and it is often impossible to find the records and witnesses that are necessary for properly presenting the case. Besides, law cases are notoriously expensive, while arbitrations may involve only a few hours of work on the part of the arbitrators. The fee to be paid to the arbitrators and the decision as to who is to pay it should be left to the arbitrators, or else each side should pay for the arbitrator it retains, while the payment of the third member is decided by the three members acting together as a board.

The following is a typical lump-sum form of contract.

MEMORANDUM OF AGREEMENT made this twentieth day of February 1945, by and between HENRY V. MALLIN, of 494 Fifth Avenue, New York City (hereinafter called the Owner), and ALSPACH CONSTRUCTION Co., INC., of 30 West 42nd Street, New York City (hereinafter called the Contractor),

WITNESSETH: That for and in consideration of the agreements herein contained, it is agreed by and between the parties hereto, as follows:

1. The Contractor agrees to furnish all the labor, materials, equipment, tools, and supplies for constructing and completing the hereinafter described house (hereinafter referred to as the work).

The Owner agrees to pay to the Contractor the sum of money hereinafter mentioned at the times and in the manner and upon the terms and conditions hereinafter set forth.

2. The house to be constructed under this contract is to be a one-family house constructed on the Owner's property at 110 Park Avenue in the Village of Flor-

ence, Nassau County, New York. The exact location, dimensions, and other characteristics of the house are given in the specifications and plans hereinafter mentioned.

3. The work is to be in strict accordance with the specifications dated February 5, 1945, prepared by John Edgar Smith, Architect, and the plans referred to therein, which specifications and plans have been signed by the parties hereto and are hereby made a part of this contract.

4. The Contractor will prosecute the work diligently at all times until completion and upon completion will leave the work complete and perfect. He will not have materials provided or obtained, nor will he have work performed or labor or means employed in the carrying out of this contract that would in any way cause or result in suspension or delay of, or strike upon the work.

5. The Owner will pay the Contractor for the work, subject to additions and deductions as hereinafter provided, the sum of FOURTEEN THOUSAND SIX HUNDRED DOLLARS (\$14,600).

Payments to the Contractor will be made in current funds and in installments payable on the fifth day of each month in amounts not to exceed ninety percent (90%) of the value of the work done and materials substantially incorporated in said work on the last day of the month preceding. The other ten percent (10%) will be retained by the Owner as part security for the faithful performance of the work, this amount to be retained until thirty (30) days after the entire work has been completed and the Contractor has paid all claims for labor and material furnished on said work.

The right of the Contractor to receive any payment hereunder shall be evidenced by a certificate issued by the Architect. No payments made or certificates thereof will in any way be construed as an acceptance of any part of the work, nor will the same in any way lessen the total and final responsibility of the Contractor.

Prior to final payment and as a condition thereto, the Contractor will furnish the Owner with a verified statement that all bills and claims have been satisfied, and a release of all claims against the Owner, arising under and by virtue of this agreement.

6. This agreement, and the specifications and plans referred to herein, may be modified and changed from time to time, as may be previously agreed upon in writing between the parties hereto, in order to carry out and complete more fully and perfectly the work herein agreed to be done and performed.

The Contractor will submit a written proposal covering each modification or change, at the request of the Architect, within ten days after receipt of such request, and such proposal shall be accepted or rejected by the Owner within ten days. In the event of rejection because of the price quoted in the proposal such modification or change may be paid for, at the option of the Owner, on the basis of cost of labor and materials and insurance, plus twenty percent (20%).

7. The Contractor will procure all necessary permits and licenses, abide by all applicable laws, regulations, ordinances, and other rules of the States or political subdivisions thereof, or any other duly constituted public authority. He will assume, pay, and be responsible for any and all taxes and contributions under Federal, State, and Municipal tax laws arising as a result of this agreement.

8. In case the parties hereto cannot agree as to the interpretation of any part of this agreement, the same shall be determined in accordance with the arbitration laws of the State of New York. One arbitrator will be chosen by the Owner, one by the Contractor, and the third by the two so selected, and the decision of a majority of the said three persons will be binding upon the parties hereto.

IN WITNESS WHEREOF, the parties hereto, for themselves and their respective heirs, executors, administrators, and assigns, executed this agreement the day and year first above written.

Attest:

\_\_\_\_\_  
John W. Randolph

\_\_\_\_\_  
Henry V. Mallin  
Alspach Construction Co., Inc.  
by

Attest:

\_\_\_\_\_  
George H. Cabot  
Secretary

\_\_\_\_\_  
William T. Alspach  
President

The following is a management or "cost-plus" form of contract:

MEMORANDUM OF AGREEMENT made this seventh day of March 1945, by and between Williamstown Manufacturing Co., Inc., of Williamstown, New Jersey (hereinafter called the Owner), and George H. Cooper, Inc., of 490 Fifth Avenue, New York, N.Y. (hereinafter called the Construction Manager),

WITNESSETH: That for and in consideration of the agreements herein contained, it is agreed by and between the parties hereto, as follows:

1. The Construction Manager agrees to furnish the full use of its business and technical organization and skill for constructing the hereinafter described building (hereinafter referred to as the work).

The Owner agrees to pay to the Construction Manager the sum of money hereinafter mentioned, at the times and in the manner hereinafter set forth.

2. The building to be constructed under this agreement is to be a three-story factory building, approximately eighty feet wide and four hundred feet long, built on the Owner's property in Williamstown, New Jersey. The exact location, dimensions, and other characteristics of the building will be given in the specifications and plans which the Owner will furnish to the Construction Manager.

3. The Owner will pay the Construction Manager a fee equal to eight percent (8%) of the cost of the work as defined in Section 5. Payments will be made in current funds and in installments payable weekly and equaling eight percent (8%) of the amount of the expenditures made during the preceding week as hereinafter mentioned.

4. The Construction Manager will work in cooperation with the Owner's architects and engineers and will assume such responsibility as the Owner may delegate to it. The Owner will have full control of the work in all its phases.

The Construction Manager will prosecute the work diligently at all times, acting as the agent of the Owner.

The Construction Manager will make all payments for the work from funds advanced by the Owner for the purpose, and render weekly detailed statements of receipts and expenditures, supported by proper vouchers. All discounts and rebates are to be credited to the cost of the work.

5. The cost of the work above mentioned is the total of the "Job Cost" and includes the cost of all materials, labor, equipment, subcontracts, permits, taxes, insurance, contributions, and all other costs and expenses incurred directly in connection with the work.

6. The fee above mentioned includes the services of the entire headquarters office of the Construction Manager, as presently constituted, in the organization and administration of the work, as may be necessary.

7. This agreement may be terminated by either party hereto by serving a four days' written notice to that effect upon the other party.

IN WITNESS WHEREOF, the parties hereto, for themselves and their respective heirs, executors, administrators, and assigns, executed this agreement the day and year first written above.

WILLIAMSTOWN MANUFACTURING CO., INC.

Attest:

By:

\_\_\_\_\_  
Secretary

\_\_\_\_\_  
President

GEORGE H. COOPER, INC.

Attest

By

\_\_\_\_\_  
Secretary

\_\_\_\_\_  
President

### Exercises

1. What are the essential requirements of a building contract? (60 to 100 words.)
2. What is a lump-sum building contract? (50 to 75 words.)
3. What is the management type of building contract? (50 to 75 words.)
4. What is meant by arbitration? (50 to 75 words.)
5. Write at least 200 words of notes on contracts, taken from one or two of the books listed in the Preface. Name the books used.

## CHAPTER VII

### THE TECHNIQUE OF ESTIMATING

When one speaks of an estimate in connection with building work, he generally refers to the regular estimate that is used for computing the amount of the contract price.

Preliminary, or budget, estimates are sometimes made up to find the approximate cost of a proposed building. These are usually made before the plans and specifications are complete. Such an estimate enables the architect to gauge the extent to which he may go in developing the details of the work on the final plans and in the specifications. Financial arrangements also may require a preliminary approximation of the cost.

**A preliminary estimate** may be quite comprehensive in scope. If it is to be used as a guide for the owner in determining his total expense, a preliminary estimate may include such items as the cost of the property upon which the proposed building is to be built. The legal costs of transferring the ownership of the property from other parties may also be shown. The owner's cost of investigating into the proposition, his expense for architects' and engineers' fees, the interest on his money for temporary and permanent financing of the undertaking, and other items not commonly considered by builders' estimators may have to be included. Often, a contractor is given a set of preliminary sketches that show the proposed building but do not include walks, roads, floor coverings, lighting fixtures, decorations, and other items that are obviously necessary to make the building complete and ready for use. If it is intended to serve for the owner's full guidance, an honest preliminary estimate should list all these items and any others that the person making the estimate can think of as possible items of expense. They should be listed by name without figures after them, if no figures are available. Among the items that might be included are taxes and insurance to be borne by the owner, besides an allowance for additional work that may be ordered and for furnishings, the operation of the building, maintenance costs, etc.

**The regular estimates** are made up by the general contractor's estimator, while preliminary estimates are sometimes made up by the architect or by an agent of the owner, instead of in a contractor's office. As preliminary estimates seem to have an annoying tendency not to agree with the final estimates, those to whom they are submitted should always be warned that the former are only rough approximations and that it is not safe to regard them as anything else.

Some contractors make a habit of using what may be called "working estimates." These are prepared by the estimator—or by the superintendent when another man's check is desired—after word has come that the contract is to be secured. They are made up in much the same style as the regular bidding estimates, but much more detail is placed on them, so that they form valuable aids in the management of the job. The plans and specifications are carefully checked over and all adjustments are made up to this point. These working estimates form the basis for awarding the subcontracts and for preparing the material lists, construction schedules, and other working data.

Regular printed forms for estimates and material lists are obtainable, as well as standard forms for contracts of all kinds. Although some contractors use these, most either do their estimating on stock-type journal-ruled pads, or else have estimating sheets made up to suit their own ideas.

In the main heading of the estimate is put the name or type of building, its location, the owner's name, and the architect's name. Some estimators give a brief description of the building, its size, the number of stories in height, the type of construction, the cubical contents, and other information.

The cost of doing different kinds of construction work under different conditions cannot be exactly determined, but, if the plans and specifications are well prepared, there is no question that the costs can be approximated very closely. The greater part of estimating, however, is done by very loose and unscientific methods; figures are based on limited rather than broad experience, and many factors of great importance are left out of consideration.

The best method of estimating any kind of building work is to determine in the simplest way possible, yet with a reasonable degree of accuracy, the number of units of work to be done. In some cases this may mean the amount of material required, but usually it is not so simple as that. In their effort to oversimplify the work, careless estimators are led into omissions.

**The estimate** should be a complete story of the construction work—in builder's language. It should be so arranged and so worded that the man who made it or any other man familiar with building estimates may be able to obtain from it a clear mental picture of the proposed work in all its parts.

Estimates, schedules, and material lists are generally arranged in the same order as specifications; that is, in the sequence in which the trades commence work on the job. The mechanical lines, however, such as plumbing, heating, and electrical work, are more often put at the end.

The estimate is divided, in general, according to the branches of work that are required on the particular job under consideration. There is no definite arrangement to be followed. The divisions are made for convenience in pricing the work that is to be done. They do not conform to the divisions used in the architect's specifications; these may not suit the method of handling the various parts of the job from a construction standpoint.

The heading for the first part, or division, of the estimate is *Excavating*, as excavation is usually the first work to be done on the job. However, if there are on the property any old buildings or other structures that have to be removed, a preliminary heading *Demolition*, or *Clearing Site*, would be required.

A division of the estimate is not necessarily confined to the trade that the heading might indicate. The heading *Concrete Work*, for example, will very likely include some carpenter work (for installing the temporary forms) and some metal lathers' work (for installing the reinforcing steel rods or mesh), as well as that of the concrete workers themselves. The heading *Plastering* nearly always includes lathing too, as only established custom has made the name "plastering" the one to be commonly adopted. This heading is, in fact, sometimes extended to *Lathing and Plastering*. These are examples of divisions that embrace more than their names indicate.

Other headings may include less than the name indicates. *Carpentry* is one of these. Although under this heading are mentioned all the items that are customarily grouped there, not all work to be done by carpenters will usually be listed among these items. As has been mentioned before, the carpentry of installing the temporary forms used to support concrete is more often placed under the heading of *Concrete Work*. Another part of the job done by carpenters is the installation of *kalamein* work (metal-covered doors, etc.). This special branch of carpentry is usually set up under a separate heading in specifications and estimates. Sometimes, however, particularly in specifications, it may be included under *Carpentry*.

In spite of this apparent lack of definite rules, the experienced estimator finds little difficulty in arranging his estimate.

**Neatness and order** in the form of the estimate will help to eliminate errors. Besides, the student should try to be systematic and to develop a uniform method of working, arranging the entries so that the result will be both artistic and easy to read.

Some estimators use colored pencils to check off the items on the plans as they are listed on the estimating sheets. This is an aid in some lines of work and on some kinds of jobs. One danger of this practice lies in

assuming that the check marks cover all the items required—in other words, in marking the items that were seen and listed and failing to look further for other items that may have been missed. Experienced estimators seldom mark plans.

Some estimators use separate sheets for pricing the quantities, which are first grouped on the take-off sheets and then carried forward to these pricing sheets. This is desirable on large jobs, where many sheets are necessary for the take-off for each line of work. In this case, an accurate check should be made to see that all the items are actually carried over to the pricing sheets. On smaller jobs it is perhaps better to price directly on the same sheets with the quantities, thus eliminating any possibility of failing to carry over all the items. This method also keeps all the work of an item in one place. Thus, if any corrections or adjustments are required, there is only one place, instead of two, in which to make the changes. For the same reasons, on the smaller jobs it is best to dispense with summaries and grand summaries.

Calculations should be made by the estimator and then checked by another person. In busy offices where adding machines and calculating machines are used, the process is reduced to a simple matter of mathematical checking, which can be done by any office assistant after a little practice. Every reasonable effort should be made to have the estimate entirely correct.

**Check lists** are helpful toward catching items that may be omitted, but, because of the vast number of possible items, it is impracticable to have complete lists. A standard job expense sheet is generally used, however. On this all the items that are expected to be encountered in this category are already enumerated and, therefore, serve as a check. Here the items of scaffolding, hoisting, temporary protection, temporary heat, and others that are likely to be omitted entirely are picked up. Even if an item is included on another sheet there is no harm in having it appear here also, as it can easily be crossed out if not needed. Many contractors, in order to make sure that their insurance costs are not overlooked, carry these costs on the job expense sheet, instead of attempting to include such large items on all the various sheets having to-do with the divisions of the work.

It is impossible to use anything in the nature of standard costs for reference in the pricing of estimates. Even cost records kept by the contractor's own office are not reliable to the extent that they may be safely used for all estimates. So many factors enter into the actual cost of building work that each job is a problem in itself. However, accurate cost records should be kept of all work done, in order that the estimator may keep generally abreast of actual costs as far as possible, and also that they may serve the purpose of finding changes made in the work

that have, perhaps, not been properly charged to the owner. To help toward better estimating thereafter, cost records should also be used to bring out errors and omissions made in the original estimate. Figures 7, 8, and 9 show typical cost record sheets.

**The plans and specifications** are examined first, by the estimator, in order that he may become familiar with the job that is to be estimated. No definite procedure that will be applicable to all jobs can be given, but certain rules do apply. Generally speaking, in the arrangement of the estimate the same order is followed as in the construction of the building, beginning with the excavation and proceeding with the various divisions in the order that the work of the different lines starts at the job. A good specification follows this order, too, and, when this is the case, it may be possible for the estimator to follow the exact order of the specification. However, as has been stated before, nearly all specifications show an overlapping of items and it is the responsibility of the estimator to see that every item is provided for and that none is duplicated. He must be experienced enough to feel that the prices he applies to his estimates will be correct for every important item and suitable for the conditions that will probably be required by the particular job under consideration.

An estimator likes a specification that states definitely just what is to take place on the job, exactly what materials are desired and what their quality should be, and exactly what will be done about inspecting the work in its various parts—in short, one that thoroughly covers the whole work. If the architect expects to see a thoroughly manned job, with ample job office and supervision facilities, instead of one that has only a superintendent (acting also as timekeeper, material clerk, layout engineer, etc.), he should so state in his specification, calling for what he wants. Otherwise, many contractors will be tempted to under-man the job, in order to save expense, and then the quality of the work will of course suffer. It would not be a bad idea for architects to enumerate the non-working positions and, perhaps, to state the minimum salary that each is to carry and the period during which each position must be filled, with credit to be made to the owner for any saving effected.

Plans and specifications must be checked carefully by the estimator. When a contract is signed, it is usually for all the work called for in the specifications or shown on the plans. This means that an architect does not have to include all the work in the specifications alone, but may show some of it on the plans without mentioning it in the specifications. For this reason, estimators double-check against the plans, and from their knowledge of construction work are always able to add a number of items in their estimates for work that is not in any way mentioned in the specifications. Architects are not closely enough in touch with builders' problems to enable them to arrange their specifications so that these may

be relied on entirely, either in first figuring the job or in using them as a basis of direct reference in awarding subcontracts. There are many overlappings and omissions.

**The examination of the site** should be made before the estimate is very far advanced. An experienced estimator will investigate the conditions relative to the handling of materials, the storage of these materials, the distance to the railroad (especially if carload shipments are expected), the means of unloading and transporting from the cars, etc. Some materials require temporary protection and substantial covers, sheds, or platforms. These temporary conveniences should be listed and measured and priced on a unit basis, just the same as other carpenter work. The maintenance and dismantling of temporary work often is not given the right amount of consideration in estimating. Temporary water lines and temporary heating often entail extra expense to a large amount, because of the daily (and sometimes nightly) attention required for proper maintenance. Even the work of unloading and stacking materials may require the inclusion of a large sum of money in the estimate, especially if it involves the handling of heavy or fragile materials and especially also if the items must be carried or wheeled a considerable distance from the point of unloading to the places where they may be stored. Matters such as these reveal an estimator's practical knowledge of job problems; he has to visualize the working conditions in order to know what to expect and what to provide for.

Comparison has often to be made between the cost of materials delivered to the job by truck and the cost of the same kind of materials shipped by freight and then unloaded and hauled to the job. When they are shipped by freight, the uncertainty of delivery on time must be judged, as well as the availability of sufficient storage space for large lots of material. If carload shipments require that temporary storage sheds be built for protecting materials until they are needed, it may very well prove foolish to set down a low price and later have to face the cost of the sheds. If there is not an abundance of room around a job and if materials must be stacked close together and close to the work, it will probably be necessary to move some of them more than once—and every handling adds to the expense. Speaking of crowded conditions, it sometimes happens that a job is so cramped that men cannot work to advantage. In cases like this, the lower output of work must be carefully taken into account. In addition, overtime work may become necessary, entailing premium pay for those men who work overtime, either to move materials or to do construction work that must be accomplished in order that the job may run smoothly the following day. This overtime work, moreover, may all be made necessary by poor judgment in ordering the materials.

Labor conditions at the site must be looked into if they are not already known. The availability of sufficient men of the proper kinds is important to the smooth running and proper sequence of the work.

What is to be done with excavated material that is needed at the site for backfilling or for filling inside the building should be given thought in the pricing of an estimate. In some extreme cases, it is better to haul away part of this material and then haul it back or buy other material for filling, rather than to have piles of dirt in the way of the men for a considerable time, which may prove more expensive, if this dirt has to be moved out of the way several times. It may even be more economical to concentrate on the foundations of one part of the job, letting the other parts wait, and then to backfill the first part with the material taken from the other parts. All these things, of course, are considered under the heading of Excavating. They are discussed here because of their importance in relation to the inspection of the site.

The expected date of delivery of the structural steel is often the deciding factor in the consideration of the general handling of jobs involving steel. Even the handling of the excavating may be affected by it. If the steel is expected quickly, the plan would be to concentrate on those footings that are to receive the first steel deliveries and in this way enable the work to proceed continuously thereafter, with the structural frame of that part of the building, even before the other portions of the building have been started. Thus the steelwork affects excavating, concrete work, backfilling, and perhaps other work, besides.

A general study of the method of laying out the job and running it is made at the time the estimate is being prepared. An approximate progress schedule will be found helpful in this connection. It may prove better economy to spend more money speeding up some parts of the work in order to be better prepared to do other parts. It may also be found necessary to speed up portions in this way, just to meet promised dates of completion that may be contained in the contract.

**Waste** is an element of cost. Forms for concrete involve waste if they can be used only once or twice on a job, rather than a great number of times. Concrete may be wasted if the forms are made larger than called for or if some of it has to be thrown away because too much has been ordered for a particular pouring or because the forms are not ready to receive it. Mortar for brickwork drops to the ground and is wasted, or too much is made and the surplus is thrown away. Improper mixing of concrete or mortar at the job may involve the use of more cement, the expensive ingredient in these items, and thus both money and time are wasted. Estimators often wonder where all the cement goes on a job. Perhaps if they saw the work being done they would note this waste. One careless, wasteful man can throw away hundreds of dollars' worth

on a good-sized job if he has a position in which he controls the supply of an item like cement. The fault, of course, lies with the foreman or superintendent in his not checking figures every few days and so discovering these "leaks."

It will be seen that the estimator must take into account the type of men his company employs for supervisors. The saving effected by paying low salaries may be ten times offset by the inefficiency or lack of interest shown by men of poor quality or by men who are being under-paid.

Face brick and glazed-tile blocks break in transit and while they are being moved about the job, lumber and scaffold planks break, doors and windows become marred so that they have to be rejected. All these and other items of waste must be considered by the estimator and provided for. On some jobs there will be very little such waste, but on others, especially where speed is essential or where carelessness and lack of system prevail, it will amount to a considerable loss.

A regular and recognized form of waste is always allowed for in figuring lumber, because of the manufacturing processes used and established customs in the lumber business. A board foot is said to be equivalent of a board one inch thick and one square foot in area, yet if a floor is to be covered with ordinary wood flooring it is found that instead of 100 board feet being required for a room  $10' \times 10'$ , nearer to 135 board feet is required. In this case, 100 square feet does not equal 100 board feet, even with boards 1" thick. This is because the stock from which the flooring is made, and not the lumber actually received, is charged for. This is a trade custom and is inescapable.

Flooring that, when laid, covers a width of  $2\frac{1}{4}"$ , is made from 3" width stock. Thus a loss of  $\frac{3}{4}"$  is entailed in every piece, owing to the forming of the tongue and groove alone. In addition to this, when the flooring is being laid, it is necessary to throw away bad pieces so that a further loss is sustained. Ends of pieces are cut off in order to fit the flooring boards into the size of a room and many small ends are thrown away. This is all called "waste," although it is not all caused by the men on the job. Another source of loss in the matter of flooring is that one does not even get the thickness that is charged for. Flooring may come only  $\frac{3}{4}"$  thick, or even less, yet it is counted 1" thick. This is because another trade custom says that lumber less than 1" thick must be figured the same as if it were 1" thick.

Flooring and other lumber over 1" thick is figured at the stock thickness from which it is made. Even timbers, such as floor beams, are scant of the dimensions shown in estimates and in purchase orders. A so-called  $2" \times 10"$  timber means one that is made from  $2" \times 10"$  stock; actually it will measure only about  $1\frac{3}{4}" \times 9\frac{1}{2}"$  when received at the job.

**Contingencies** make it difficult for the estimator to provide for their effects and yet have his estimate low enough to win the contract. Winter weather must be taken into account if the work is to extend into that season so that temporary enclosures and temporary heating will have to be provided, and so that the loss of efficiency caused throughout the job during bad weather will have to be met. Incidentally, if a job is expected under normal conditions to be closed in before bad weather comes, and if additional work is given by the owner or changes are made that hold up the work, the estimator, immediately upon finding this to be the case, should have compensation demanded from the owner for any protection or other extra winter costs thus made necessary.

If a job is to last several months, it may very well be that the wage rate of one or more of the trades will be increased before the work is completed. Rarely is it possible for the contractor to get any additional money from the owner for this increased cost. Some subcontractors always put into their estimates a clause stating that they will not be responsible for any increase that their men may demand during the life of the job. The general contractor is thus forced to carry not only his own risk in this regard but that of his subcontractors as well.

The time required for constructing a building is of great importance to a contractor, because his funds and also his working staff are tied up in the work. To become too involved in jobs may cause his financial ruin, especially if his funds are limited. For this reason, it is better for him to stop figuring new jobs for a while and to use the estimating talent in connection with jobs already on hand—toward securing better efficiency on them and toward completing them sooner than would otherwise be the case. Too little work on hand is bad, but too much work on hand may be worse.

It is always necessary to make an analysis of the specifications and plans before starting an estimate. Enough detail should be incorporated in this analysis so that it will form a complete check list. First the specification is analyzed and then items from the plans are added to the list, as well as other items, gathered from the estimator's own knowledge of construction work and of the special requirements that will be involved in the particular job being estimated. It is the estimator's duty to see that every item of expense is included in the estimate, either among his own items or among those of the subcontractors whose figures he incorporates in the estimate.

**Subcontractors' estimates** require careful study before the figures presented in them may be used. First of all, the work included by the subcontractor in each case must be ascertained. Even those estimates that read "according to the plans and specifications" may not, when studied, really cover all the work that at first glance may seem to be included.

Because a plumbing contractor, for example, says that he has included all the work in his line does not necessarily mean that he has accounted for all the items that the architect chose to specify under the heading of Plumbing. The architect may have mentioned in the plumbing section many items of equipment that are ordinarily hooked up by the plumbers, but the plumbing contractor can take the stand that these items, or some of them, are to be furnished by other parties and not by him, that he is merely to hook them up to the plumbing system. Thus the cost of furnishing all such items may be omitted from the estimate if care is not exercised. Similarly, if an electrical contractor says that he has included all the work called for in his portion of the specifications, he may not be counting in the lighting fixtures, if they have not been specified therein, even though they may be shown and perhaps listed in detail on the plans,

The lowest subcontract estimate in a given line is not always the best to choose. One that is far below the other estimates received should be checked very carefully before being incorporated in the contractor's own estimate. For one reason or another the subcontractor may not take the job if it is offered to him. He may have found out in the meantime that he made a mistake in figuring or that he omitted some of the work. Even if he signs a contract at the low figure he submitted, trouble may start while he is working on the job; he may find that he is losing money and ask for more than he contracted for, or he may be financially unable to proceed. At any rate, he probably will not be very enthusiastic about the work or give it proper attention, such as he would give if he had the prospect of a good profit. All these things must be in the estimator's mind as he weighs the pricing of his estimate for the whole job, and every reasonable precaution must be taken.

Subcontractors often wish to use a different material or one of a different grade from that specified. Sometimes they state this in their estimates, perhaps noting the substitute; and sometimes they take a chance and later state that they had anticipated using different material. If the substitution is perfectly fair, usually no trouble results; but in other cases a dispute may ensue. At the time of estimating there is no opportunity to take any action on what the subcontractor may have in mind to do afterward. If, however, a subcontractor in his estimate gives any intimation that he plans to make a substitution or if he verbally states any such intention, the wise estimator, before using that subcontractor's estimate in preparing his own bid for the job, will make a thorough check as to the possibility of a misunderstanding.

Occasionally, a subcontractor, at the time he is figuring the job, will tell the estimator of a substitution that he plans to make, but will neglect to state this in his estimate. Later he may claim that he told the estimator and then try to force an adjustment. While there may be no

legal claim on his part, an embarrassing situation is created that should have been avoided by the estimator's taking proper steps when he first learned of the substitution plan. He should at least have given warning that it would be the architect's responsibility to accept or reject any substitutions.

Estimating, like accounting, is an established business routine and is an integral part of the business of constructing buildings. In a broad sense, it must be thought of as equal in importance to the preparation of the plans and the writing of the specifications. Estimating that is done by men not trained for it is usually based on hasty judgment or on guesses. Such estimators lack the thorough schooling in the analysis work that is necessary for the preparation of complete and reliable estimates. The methods used by some contractors in going over work preparatory to making bids are superficial almost beyond belief. In the main, these are responsible to a great degree for the losses later sustained by the contractors.

**Unfair Dealings.** Architects and owners are often not fair in their dealings with contractors. For one thing, many estimates are made for building that is never done. Yet the cost to the contractors bidding on it is never considered by those who unhesitatingly ask for bids. If a code of estimating practice is ever written, one rule should be that no bids shall be submitted unless plans for the proposed building have at least been filed with the local building department. This will tend to eliminate some of the useless bidding, because it is not likely that an architect would file plans unless the job had a fair certainty of going ahead.

Architects sometimes specify that only approved subcontractors may be used. This gives rise to confusion in the selection of subcontractors by the contractor. It could be eliminated if architects would furnish full sets of plans and specifications to the subcontractors who meet with their approval at the time bids are first asked for—at least, in the main lines of work. These subcontractors could then send a copy of each bid to each of the contractors bidding on the job and there would then be no need for doubt as to their being approved later.

Another thing that annoys estimators is to find out, after a job is well under way, that an architect had in his possession surveys and other information regarding ground levels and conditions existing at the site and in its surroundings that he did not issue with the plans when bids were asked for. It should be a rule that every bit of pertinent information that an architect has shall be passed on to the contractors bidding and thus perhaps save them from gambling on uncertain conditions.

All work should be deemed to be Union Work, with no overtime work considered. The standard form of lump-sum contract of the American

Institute of Architects, without alteration, should be understood to be used for all work. If any variation from these two requirements is desired by the architect or the owner, it should be clearly so stated in the original bidding specifications, in order that contractors and their subcontractors may take such variations into account at the time of making their original calculations.

Rock excavating, pumping, underpinning that is not shown on the architect's plans, foundation work that is not shown on the architect's plans, and other work or expense upon which it is impossible for the contractor to make a satisfactory estimate, should be paid for separately, in addition to the work proper set forth in the contract.

A fair price should be chargeable for all drafting or engineering services that contractors or subcontractors are called upon to render, whether these are called for at the time of bidding or at any other time.

Neither the contractor nor any subcontractor should be held responsible for loss due to any delay in the execution of a contract, when such delay is in no way the fault of the contractor or of one of his subcontractors; nor should any payment be held up on this account.

The contractor and each subcontractor should be paid in current funds at least 90% of the value of the work completed, every two weeks; or at least 95% every month for the work done and the materials delivered.

Every contract should provide for prompt payments and also should require final inspection and payment in full within 30 days after the completion of the work of each division of the specifications, regardless of the final settlement of the job as a whole.

Differences arising between the contractor and other parties to the contract or concerned with it should be subject to and settled by arbitration.

No changes should be made and no work should be held up pending any changes, until an agreement is entered into for the adjustment of the contract price on account of the changes. This should apply to subcontracts also.

Unless specific provision is mentioned in the contract, an extra charge should be made for any variation from standard stock materials and methods of construction.

When liquidated damages are specified, a corresponding bonus also should be included.

All the foregoing are merely suggestions of practices that would make contracting more of a business or profession and less of a gamble. They will serve also to point out some of the business troubles encountered by the estimator in his daily work.

**Exercises**

1. What are preliminary estimates? (60 to 100 words.)
2. What should a complete builder's estimate contain, and what is the general arrangement of such an estimate? (100 to 150 words.)
3. Why cannot the unit costs given in this and other books on estimating be used for all jobs? (75 to 100 words.)
4. What is the general procedure in making an estimate? (100 to 200 words.)
5. State some contingencies that an estimator must consider providing for? (60 to 100 words.)
6. How are subcontractors' estimates handled? (75 to 100 words.)
7. Write at least 300 words of notes regarding estimating procedure, from several of the books listed in the Preface. Name the books used.
8. Prepare the first sheet of an estimate for the house shown in Chap. V, with proper heading, etc.
9. Make an analysis, similar to a specification analysis, of the requirements for the house.

## CHAPTER VIII

### QUANTITY SURVEYING

**The quantity-survey** portion of an estimate lists every essential detail that will affect the cost of the proposed building, except that subcontract items are listed by name only. A quantity survey is not a material list, however, nor is it as complete as a working estimate. The essential details for computing the cost consist of the name and location of every item of work and the number of units of work involved.

Quantity surveying is the measuring of the work that is shown on the plans and specified and the listing of these items on the estimate make-up or quantity sheets. These give the amount of work under each classification, ready for pricing at so much money per unit of work. This unit price is the contractor's cost price. It includes the cost of materials, labor, equipment, scaffolding, labor insurance, and all the incidental expense entering into the items; it excludes only the portion of the general job expense that could be considered also as part of the items. The main office expense and the profit are entered in the estimate separately from these work items.

Some builders, especially the larger firms, employ men as quantity surveyors alone, leaving the pricing and summarizing of the estimate to the builder himself or to the head estimator. One criticism of this method is that it is not conducive to the proper study of the unit prices and the application of them to the items. It is better for one man to carry the whole estimate through to completion and then have the whole thing looked over or checked in detail by another person.

Quantity surveying involves reading the blueprints and scaling the quantities of work from them. Some knowledge of architectural drafting is necessary for doing this well and readily. Architectural drafting gives a keener hold on the details of the making of plans and a feeling for the work of the architect and the draftsman, which will help toward easier reading of the plans.

**A good quantity survey** is one that can be used to advantage after the contract is signed; one from which the lists of materials can be readily made up. However, it is rarely practical to enter on the original quantity survey every detail, as is required for the material lists. Most contractors are satisfied to have in mind only the winning of the contract when their office is estimating a job. They use the quantity survey and

the other sheets of the estimate to guide them and check them in making up subsequent lists and schedules. Many follow the plan of making a new, or "working," estimate as soon as they receive word that the contract is to be awarded to them. The original estimate is used as a general guide in preparing this working estimate, but all the figures are taken from the plans anew. In this way, not only is a careful check made of the original estimate as such, but more details are entered and the entire job is thoroughly studied. This makes the office more familiar with the work to be done; in fact, some contractors, with just that in mind, have the general superintendent or the engineer make the new estimate. The estimator is already familiar with the plans. The working estimate for a large job should show the items broken down, floor by floor or portion by portion of the job, in order that it may serve as a guide for deliveries of material and for other uses.

Quantity surveying should show all the items used in the estimate. These items are shown in the customary way, by means of the customary units of measure. Thus, plastering, for example, is listed as so many square yards of the different types of plastering work and not (as in a material list) as so many bags of lime, cubic yards of sand, so much lath, so much hair or fiber, etc. A list for concrete work gives the number of square feet of forms required and the number of cubic yards of concrete, all item by item of work; not the number of board feet of different kinds of lumber for the forms nor the sand, gravel, cement, etc., of which the concrete is composed.

The quantity survey shows how many thousands of bricks of each different kind are required and indicates their location in the building. A material list, on the other hand, shows all this and also the amount of sand, cement, lime, mortar color, brick ties, and other incidental items of material that are needed for producing the amount of brickwork required. All this additional information is necessary for the writing of purchase orders and is therefore entered on the material lists, after the job is secured. It is not needed in the original estimate, because the unit prices there include the cost of all these incidental materials.

Chapter IV treats of plans in general. Here the present chapter, making a deeper study of them, discusses the way to separate the work shown on them into the customary parts for estimating purposes. These divisions generally follow the same work as the trade name used in them may signify, but sometimes it is necessary to include work of more than one trade in a division of the estimate. Only by considerable practice is easy and familiar handling of such matters gained; but a knowledge of the general rules of scaling the plans is of first importance.

Symbols and conventional indications are quickly read by anyone experienced in building construction and the use of plans for this work.

In fact, some of them, like the symbols for bathtubs and lavatories, are almost pictures of the things they represent and anybody will recognize them after a little practice.

The scale rules in common use have two scales on each edge, and it is therefore necessary to be careful to read the scale that is intended to be used. The  $\frac{1}{4}$ " and  $\frac{1}{8}$ " scales, the two most used, are usually both on one edge of the scale rule, one reading from each end of the rule. Figure 26 shows a typical scale rule.

As most of the dimensions of a building are given in figures on the plans, it is not necessary to use the scale rule to find them. In fact, it is

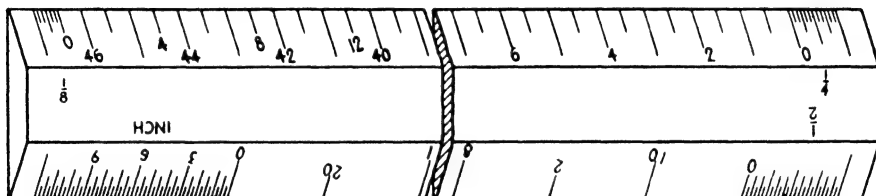


FIG. 26. --A 12" scale rule.

better always to read the figured dimensions than to scale the plans; the figures are more accurate. In any event, care must be exercised in reading the dimensions. If the scale is used, care must be taken to read the right scale, as has been said. If the plan is made to  $\frac{1}{4}$ " scale and the  $\frac{1}{8}$ " scale is used by mistake in taking a reading, the reading will obviously be twice as long as is actually required. If two dimensions, as for a floor area, are taken by the  $\frac{1}{8}$ " scale instead of the  $\frac{1}{4}$ " scale, the error will be much greater; a  $10' \times 10'$  room would read  $20' \times 20'$ , making a total of 400 square feet instead of 100 square feet!

The more familiar a student is with mathematics, the easier will he find calculation work. Higher mathematics, however, are not ordinarily used by contractors or estimators. Only in certain specialties is it necessary to have a good knowledge of solid geometry and trigonometry. Plain arithmetic, the use of fractions and decimals, and mensuration or plane geometry cover the mathematical operations used in building construction.

By cutting down the number of figures, whether in the quantities or in the pricing, the chance of making errors is automatically reduced and considerable time is saved. Therefore, an endeavor should be made to get the final results in the most direct way. Estimators, because of the limited time usually available for the preparation of estimates, find it absolutely necessary to reduce their work to the simplest number of operations consistent with accuracy. No one should attempt the study of estimating, however, until he can work readily the simple mathematical problems involved; this is a test of general ability, as well, and the general

ability thus proved is also necessary. A good knowledge of the handling of fractions and decimals is an indispensable beginning.

Some estimators, immediately after reading the dimensions on the plans, turn the dimensions of feet and inches taken from the plans into feet and decimal parts of a foot, or feet and fractional parts of a foot. They then enter these figures on the quantity sheets, instead of entering feet and inches. The theory is that this makes it easier for an office assistant to extend the figures, as he would otherwise have to use his own judgment in handling the fraction of a foot. There are three objections to this procedure on the part of the estimator: (1) It forms another mental operation for his already busy mind, as the figures are either given in feet and inches on the plans for him to read there, or else are scaled in feet and inches for him to read from the scale. Not only is he assuming the extra mental burden all through the process of reading and entering the figures, but he is adding one more opportunity for error in the handling of every entry. (2) Simplifying the work for the office assistant may seem all right, but if the assistant is of such poor quality that he (or she) cannot handle the simple calculations in feet and inches, it is to be seriously doubted that he has the ability to be trusted with the estimating sheets at all. (3) As the sheets will undoubtedly be used for later reference, the figures should be written on them in a way consistent with the method commonly used on plans and in verbal expressions among construction men—that is, in feet and inches.

The student who goes through this textbook and makes a complete estimate will probably be surprised to note the few formulas that are used in estimating. The mathematics of estimating is actually quite simple.

One rule that should be kept in mind, from a practical standpoint in estimating, is that when many items are to be extended from one set of figures, instead of using the figures for only one item, it is important that the figures thus used over and over should be right, as otherwise the error will be multiplied by the number of times that they are used. For example, if the size of a room is entered in length and width on the sheet for rough flooring and is later used, without being checked, for the finish flooring, and then perhaps for the floor scraping and finishing, and possibly for the ceiling plaster, it will readily be seen that, if the original dimensions of the room are wrong, many errors result in addition to the one regarding the rough flooring for which the dimensions were first intended. Some careful estimators make a habit of taking the measurements off separately every time they are required, and then later looking over the sheets and using the similar entries to check one another. At any rate, it is necessary always to watch out carefully for this type of error.

**Excavating** work involves measurements of length, width, and thickness (or depth), in feet and inches; and then—computed from these three

dimensions—the cubic feet of volume, and from that the cubic yards of volume. Feet multiplied by feet give square feet, and this result multiplied by feet again gives cubic feet. Thus,  $10' \times 10' = 100$  square feet, and this  $100' \times 10'$  deep gives 1,000 cubic feet. As there are 27 cubic feet in one cubic yard, dividing the number of cubic feet by 27 will give the cubic yards or, in this case, approximately 37 cubic yards.

Excavating is measured in cubic yards. This is the customary unit of measure employed for that work. If the excavation for a cellar, for example, measures 25' wide  $\times$  60' long  $\times$  7'6" deep, these three dimensions in feet (or feet and parts of a foot) are multiplied together, and the resulting number of cubic feet is divided by 27, in order to arrive at the number of cubic yards. The 7'6" in this case is treated as  $7\frac{1}{2}$  or 7.5 feet. The answer is 417 cu. yd. Figure out these cubic contents and find the same result. Then calculate the following cubic contents, also:

$$20' \text{ wide} \times 50' \text{ long} \times 8' \text{ deep} = \text{— cu. yd.}$$

$$40' \times 32' \times 6'3'' = \text{— cu. yd.}$$

$$17'6'' \times 30' \times 7'4'' = \text{— cu. yd.}$$

$$39'8'' \times 83'9'' \times 11'5'' = \text{— cu. yd.}$$

**Concrete** is, in most cases, measured in cubic yards also. Thus, to find the amount of concrete in a wall 23' long  $\times$  10' high  $\times$  1' thick, follow the same procedure as in the above cases:  $23 \times 10 \times 1 = 230$  cu. ft.; and this divided by 27 =  $8\frac{1}{2}\frac{2}{3}$  cu. yd., or practically  $8\frac{1}{2}$  cu. yd. It is not necessary to have the final answer in an odd fraction, the nearest  $\frac{1}{4}$  or  $\frac{1}{2}$  is usually accurate enough for concrete work. The nearest whole yard is close enough for excavating work.

**Cement floors** are generally measured by the square foot, so the calculation is merely a matter of measuring the length of a floor and multiplying it by the width. Thus, a floor measuring 16' wide and 34' long would equal 544 square feet. This is the required answer, as far as the quantity is concerned. This is then carried out to the pricing column and, if it is priced at, say, 16¢ per sq. ft., the cost extended would be \$87. It is not customary to show cents in the final amount. This actually is figured out to \$87.04, but is extended to the nearest whole dollar. In a long column of figures, there will be only an insignificant error if one gives and takes the cents in this way all down the line.

**Plastering** is figured by the square yard. As there are nine square feet in one square yard, find the two dimensions in feet of any area to be plastered, and multiply these two dimensions together to get the area in square feet. The result divided by 9 gives the number of square yards. Take a wall to be plastered, measuring 17' long  $\times$  8' high. This equals

136 sq. ft.; 136 divided by 9 equals  $15\frac{1}{9}$  sq. yd. Enter this as 15 sq. yd. If it were nearer to  $15\frac{1}{2}$ , it would be called  $15\frac{1}{2}$  sq. yd.

**Framing lumber** used in building work is practically all figured in board feet, and waste has to be taken into account. It is easy to figure board feet. All that is necessary is to find the number of square feet, 1" thick, or the equivalent. Thus, a board 10' long  $\times$  1' wide  $\times$  1" thick has 10 board feet. If the same board were 2" thick it would have twice as many board feet as the one that is 1" thick, or 20 board feet. If the same board as first mentioned were only 6" wide instead of 12" wide, it would have half as many board feet, or 5 board feet. For any piece of lumber, multiply the three dimensions of it together and divide the result by 12; the answer will be the number of board feet in the piece of lumber. If more than one piece is concerned, multiply the amount in one piece by the number of pieces. The dimensions are always given in inches of cross section and length in feet; thus there may be a piece of 2"  $\times$  8"  $\times$  18' (or, as spoken, 2 by 8 by 18). This piece measures 2"  $\times$  8" in cross section, and it is 18' long. Multiplying the 2  $\times$  8  $\times$  18 gives 288, and dividing this by 12 gives 24 board feet. The rule is: multiply the standard dimensions together and divide by 12.

**Wood flooring** is sometimes listed simply by expressing the number of square feet to be covered by the flooring. In this case, it would be measured in the same way as the cement flooring mentioned above. For the ordinary types of wood flooring, the number of board feet is found by adding the waste allowance to the number of square feet of floor area. Ordinary flooring is 1" or less in thickness and is therefore taken as 1" for figuring purposes. All lumber less than 1" thick is considered 1" thick for figuring purposes.

Flooring boards have a tongue-and-groove formation cut on them, which takes away about  $\frac{3}{4}$ " from the width of the boards when they are laid as flooring. Flooring boards with a face measurement of  $2\frac{1}{4}$ " are made from 3" wide stock, for example, and therefore 25% of the width is lost or taken up by the tongue and groove. To provide for this loss, add the 25% to the number of square feet of floor area, thus getting the answer in board feet. A floor 10'  $\times$  20', equaling 200 square feet of floor, would equal 250 board feet. This would be the amount of flooring to order, if every piece were good and of the right length so that no further waste would be encountered; but there is further waste, because some of the material is rejected, broken, etc., and because small ends have to be cut from many of the pieces. For this additional waste, add between 8% and 15% more, depending upon the grade of flooring specified and the kind of lumber, etc. Therefore, 200 sq. ft. of floor area requires about 275 board feet of flooring.

**All the plans** must be used in listing the items and the specifications must also be kept in mind at all times. Inexperienced estimators have a bad habit of taking measurements from one drawing alone for an item when, by reference to the other drawings, the item may appear differently and may require different treatment from that which the one drawing indicates. Reference should be made to cross sections and detail drawings, especially, more often than is usually done. The preceding paragraph gives one reason for keeping the specification requirements in mind when measuring the plans—that the grade and kind of flooring affect the percentage of waste allowance. Other examples of the importance of reading the specifications carefully and keeping them in mind while measuring the plans could also be given.

Numerous specimen quantity-survey sheets are given in the succeeding chapters. The student should look these all over now and become generally familiar with the arrangement and grouping of the items, the wording used, the layout of the measurements, and the extensions of the figures. They will be discussed further as the various divisions are taken up.

#### **Exercises**

1. What is a quantity survey? (75 to 100 words.)
2. Name several items that are customarily measured by each of the following units: lin. ft., sq. ft., cu. ft., sq. yd., cu. yd., lb., ton, M.

## CHAPTER IX

### EXPENSE AND SUMMARY SHEETS

The items of cost that most directly and obviously enter into the total cost of any building are labor and materials. Besides these, there is a cost called "expense" that cannot be regarded as either labor or material. Cost items of this sort that can be applied against a particular job are entered under Job Expense. Items of expense that cannot be applied against a particular job are entered under Overhead Expense.

**The heading Job Expense** provides for the cost of supervision, temporary construction and protection, permits, and other items that are for the use of the entire job. In some instances it is difficult to determine whether an item should be put under this heading or under some work heading. For this reason, no arbitrary rules can be laid down. One rule for the estimator to follow, however, is to see that all the expense items are properly covered in some part of the estimate.

The superintendent's salary is one of the main items, usually, of the job expense. For example, if a job is to require four months to build and the superintendent is paid \$100 per week, an expense of about \$1,700 is involved in this one item. This must be included as part of the job cost, and the proper place for it is under the heading for the general expense of running the job. In like manner, a watchman is generally needed on building jobs and, if the regular night watchman is paid \$25 per week, there will be an item here involving about \$400 more. A day watchman may be required for Saturdays, Sundays, and holidays, and this, in the example given, would add \$100 more. Of course, some jobs will not require so much watchman service and some may not require any watchmen at all. On the other hand, there are jobs where a day watchman is needed every day, and some where two or more night men must be on duty every night.

Other members of the job office personnel may include a timekeeper and a material clerk, to keep records of the men's time and pay and of the supply of materials. On large jobs there are assistant superintendents, layout engineers, checkers, tool clerks, and others. These men are not actually engaged in the construction of the building but they are needed in connection with the work on the job, and the cost involved in having them there must be taken into account. On out-of-town jobs it is the custom to send the supervising personnel from the main office. In this

case the expense will be increased, owing to the traveling expenses and, in some instances, to the living expenses of these men. Occasionally, workmen also are sent out in this way.

The following are lists of the personnel, by departments, on a large job such as that shown in Fig. 11 in Chap. IV. They show the activities attendant upon such work and serve to illustrate the elements of costs thus involved in construction work. The positions given in parentheses are held by men assigned from other departments.

#### PROJECT MANAGER'S OFFICE

Project Manager  
Assistant Project Manager  
Control Clerk  
Attorney  
Secretary  
Report Clerk  
Field Inspector  
Plan Clerk  
Mail Clerk  
Stenographer  
Typist  
Subcontractors (20)

#### PURCHASING DEPARTMENT

Purchasing Agent  
Secretary  
Building Material Buyer  
Equipment and Tool Buyer  
Track, Road, and Sewer Buyer  
Mechanical and Electrical Buyer  
Field and Office Service Buyer  
Buyers' Clerks (5)  
(Voucher Clerk)  
Local Expeditor  
Shipment Expeditor  
Traveling Expeditor  
Stenographer  
Typist  
Comptometer Operator

#### ESTIMATING DEPARTMENT

Chief Estimator  
Secretary  
Estimator  
Assistant Estimators (2)  
Draftsman  
Contract Clerk

#### ENGINEERING DEPARTMENT

Chief Engineer  
Secretary  
Office Engineer  
(Voucher Clerk  $\frac{1}{2}$ )  
Draftsman  
Layout Engineer  
Field Engineers (10)  
Rodmen (10)

#### CONSTRUCTION DEPARTMENT

General Superintendent  
Secretary  
Assistant General Superintendent  
(Voucher Clerk  $\frac{1}{2}$ )  
Night General Superintendent  
Area Superintendents (5)  
Superintendents (15)  
Foremen (120)  
Workmen (3,000)

#### TRACK DEPARTMENT

Chief Track Engineer  
Secretary  
Assistant Track Engineer  
(Buyer  $\frac{1}{2}$ )  
(Storekeeper)  
(Cost and Time Clerk)  
(Tool Clerks 3)  
(Field Engineer  $\frac{1}{2}$ )  
Night Clerk  
Track Superintendent  
Foremen (10)  
Mechanics (20)  
Laborers (150)

## ROAD AND SEWER DEPARTMENT

Superintendent of Roads and Sewers  
 Secretary  
 Engineer  
 (Buyer  $\frac{1}{2}$ )  
 (Timekeeper  $\frac{1}{3}$ )  
 (Storekeeper)  
 (Tool Clerk)  
 (Field Engineer  $\frac{1}{2}$ )  
 (Cost and Time Clerk  $\frac{1}{3}$ )  
 Night Clerk  
 Foremen (2)  
 Maintenance Men (20)  
 Subcontractors (3)

MECHANICAL ENGINEERING  
DEPARTMENT

Mechanical Engineer  
 Secretary  
 Plumbing Superintendent  
 Plumbing Foreman  
 Plumbers and Helpers (6)  
 Heating Superintendent  
 Heating Foreman  
 Steamfitters and Helpers (6)  
 (Buyer  $\frac{1}{2}$ )  
 (Storekeeper)  
 (Tool Clerk  $\frac{1}{2}$ )  
 (Cost and Time Clerk  $\frac{1}{3}$ )  
 Night Clerk  
 Subcontractors (3)

ELECTRICAL ENGINEERING  
DEPARTMENT

Electrical Engineer  
 Secretary  
 Assistant Electrical Engineer  
 (Buyer  $\frac{1}{3}$ )  
 (Cost and Time Clerk  $\frac{1}{3}$ )  
 (Storekeeper)  
 (Tool Clerk  $\frac{1}{2}$ )  
 Night Clerk  
 Foremen (2)  
 Maintenance Men (20)  
 Subcontractors (2)

## MATERIAL DEPARTMENT

Department Manager  
 Secretary  
 Night Manager  
 Head Checker  
 Checkers (20)  
 Truck Router  
 Chief Storekeeper  
 Storekeepers (8)  
 Lumberyard Manager  
 Lumberyard Foreman  
 Lumber Handlers (10)  
 Lumberyard Clerks (3)  
 Mill Manager  
 Mill Foreman  
 Mill Carpenters (40)  
 Mill Clerks (3)  
 (Buyer)  
 (Cost and Time Clerk)  
 Stenographer  
 Typists (3)

## EQUIPMENT AND TOOL DEPARTMENT

Department Manager  
 Secretary  
 Assistant Manager  
 Stock Clerk  
 Salvage Clerk  
 Stenographer  
 Typists (2)  
 (Voucher Clerk)  
 (Cost and Time Clerks 2)  
 (Buyer)  
 Equipment Superintendent  
 Equipment Clerks (2)  
 Equipment Operators (100)  
 Tool Superintendent  
 Tool Clerks (10)  
 Truck Superintendent  
 Truck Clerks (2)  
 Chauffeurs (100)  
 Field Checkers (6)  
 Repair Manager  
 Master Mechanic  
 Assistant Master Mechanic  
 Repair Men (4)

Oil and Grease Man  
Gas-station Attendant

#### FIELD SERVICE DEPARTMENT

Department Manager  
Secretary  
Safety Engineer  
Canteen Supervisor  
Rubbish Foreman  
Rubbish Men (20)  
Scrap Clerk  
Medical Doctor  
First-aid Men (6)  
(Auxiliary First-aid Men 6)  
Nurses (6)  
Orderlies (2)  
Ambulance Drivers (3)  
Accident Clerk  
Police Chief  
Assistant Police Chief  
(Auxiliary Chiefs 5)  
Guards (75)  
Fire Chief  
Assistant Fire Chief  
(Auxiliary Chiefs 5)  
Firemen (10)  
(Auxiliary Firemen 30)  
Fire-truck Drivers (2)  
Bus and Car Manager  
Bus and Car Clerk  
Bus and Car Drivers (80)  
Field Messenger  
(Storekeeper)  
(Buyer  $\frac{1}{2}$ )  
(Cost and Time Clerks 2)  
Chief Waterboy  
Waterboys (75)  
Stenographer  
Typist

#### OFFICE SERVICE DEPARTMENT

Department Manager  
Secretary  
Night Service Manager  
Assistant Department Manager  
Stenographers (4)

Typists (4)  
Comptometer Operators (4)  
Mimeograph and B/P Operator  
Personnel Manager  
Personnel Clerks (4)  
Labor Relations Manager  
Receptionist  
Messengers (8)  
(Storekeeper)  
(Cost and Time Clerk)  
(Buyer  $\frac{1}{2}$ )  
Head Janitor  
Janitors (4)  
Matrons (2)  
Head Switchboard Operator  
Switchboard Operators (4)

#### TIME AND COST DEPARTMENT

Department Manager  
Secretary  
Chief Timekeeper  
Timekeepers (4)  
Pay-roll Clerks (7)  
Pay-roll Typists (4)  
Pay-roll Comptometer Operators (5)  
Chief Cost Clerk  
Cost Clerks (3)  
Time and Cost Clerks (6)  
Field Checkers (10)  
Cost Typists (3)  
Cost Comptometer Operators (2)  
Paymaster  
Assistant Paymasters (4)  
Termination Clerk  
Night Clerks (2)  
Bookkeepers (3)  
Stenographer  
Typist  
Comptometer Operator

#### ACCOUNTING DEPARTMENT

Chief Auditor  
Secretary  
Assistant Chief Auditor  
Auditor of Disbursements  
Assistant Auditor of Disbursements

Voucher Clerks (6)  
 Cashier  
 Reimbursement Clerks (2)  
 Social Security Clerk

Bookkeepers (3)  
 Stenographers (2)  
 Typists (3)  
 Comptometer Operators (2)

**Temporary job offices, tool houses, storage sheds, and other such conveniences are part of the expense of carrying on a job.** Temporary fences, barricades, runways, bridges, stairways, and platforms are also

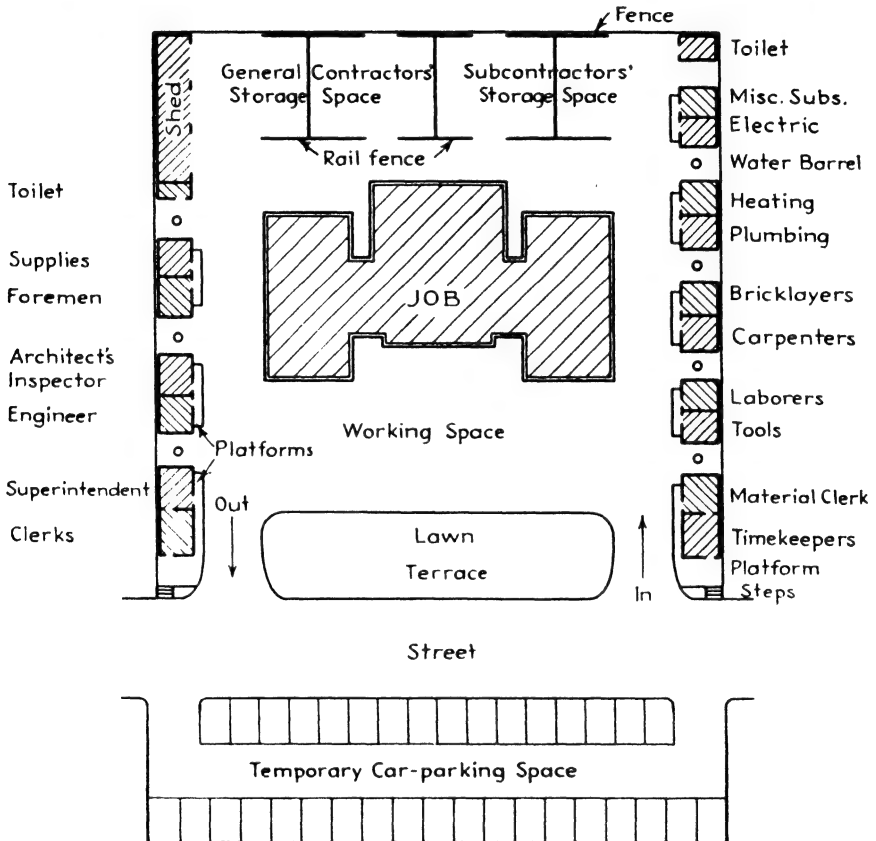


FIG. 27. Layout of a construction job.

to be considered as items of cost. The law demands that proper safeguards be constructed and maintained in good order to prevent accidents at open shafts, wellholes, and other places that are likely to be the locations of accidents if not so guarded. The law also demands temporary toilets, drinking water, and other conveniences for the health and comfort of the men. Trade unions demand these and other things, besides. Figure 27 shows the layout of the temporary construction and conveniences for a typical job. Fortunately, at this project an open plot across

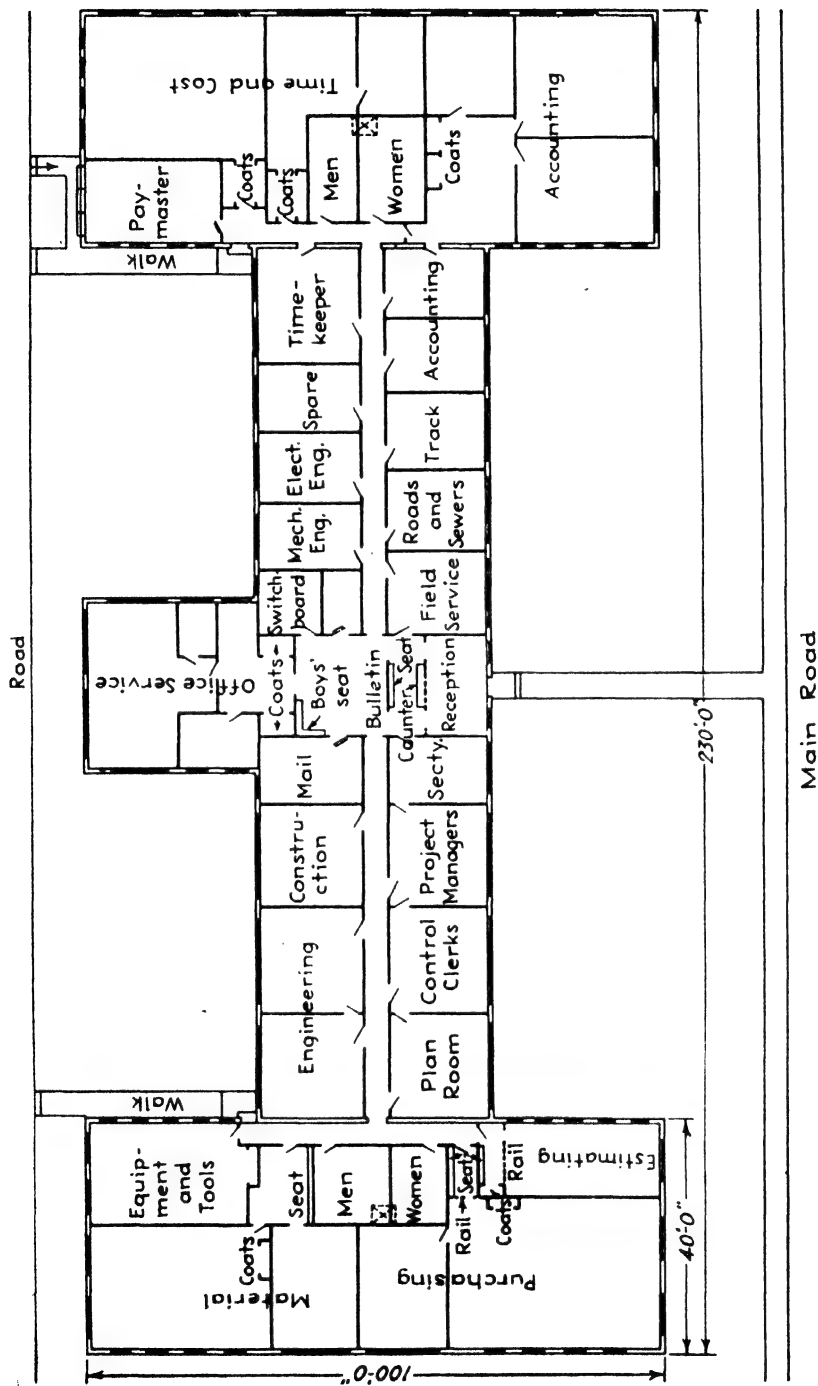


Fig. 28.—Job office on a large project.

the street was available, where parking space was provided for the many cars in which the men came to work. Figure 28 shows the plan of the temporary job office building used on a large project. This "shanty," which cost as much to build as a good-sized house, has more plumbing in it than a house would require.

Openings in the walls for doors and windows often have to be closed before the doors and the window glass have arrived at the job. The custom is to tack muslin in the openings that are not needed for access to the work. Some openings, however, must be provided with temporary doors. Enclosures are often required, especially during the winter months, to protect the men from the weather before the walls are advanced far enough so that merely covering the door and window openings is adequate.

If a structure over 40 feet high is to be erected or if one over 25 feet high is to be demolished, a sidewalk shed is usually required, unless the distance from the structure to the sidewalk is considerable. In large cities, catch platforms must be erected on the front of a building that is over a certain height, while it is being demolished. Furthermore, the law demands that fences be built along the front of jobs in certain locations, and civic associations do their best to have main thoroughfares kept in tidy condition, with neatly built front enclosures for construction work.

**Water and light** are common requirements for building work; yet many estimators neglect to make provision enough in their estimates for these items. Water involves not only the water charges, but also the installation, maintenance, and removal of the temporary lines, and the changing about of these lines when that is necessary. Similarly, for temporary light and power there is the charge for current, the cost of installing and maintaining the lines, the electrical union's demand that union electricians be kept in attendance merely to turn switches on and off, and the cost of bulbs and fixtures.

To heat a construction job in winter is a costly undertaking. Some of the elements of this cost are the installation and first cost of the system or devices used for heating, the fuel cost, the additional temporary enclosure work required, the labor of attending to the heating, the repairing and rearranging of the equipment, the loss of time resulting from the men's working under these conditions, and the extra cost of supervising, etc.

There is often need for temporary stairways or temporary treads for the permanent steel stairs in large buildings. The law requires these to be safe and secure, and this means that substantial guardrails must be provided. Temporary toilet and locker rooms must be considered, too.

There are many small items in the job office that add up to a considerable sum on large operations. One of these, and one that should

not be called very small, is the job telephone cost. A monthly bill of from \$50 to \$200 is common on a busy job of fair size. Office furnishings, stationery, and supplies often amount to \$200 on a job.

Repairs to streets, walks, lawns, and other parts of the property and of adjacent property, as well as permits and deposits in connection with them, sometimes account for a large group of cost items and must be considered on all jobs. In fine building work, all the finished surfaces, corners and mouldings of stone, marble, tile, cabinetwork, bathroom fixtures, and equipment of all kinds have to be protected from damage that might result from exposure before the building is completed and from damage that might be caused by men or materials for other parts of the work. Repair costs for all these items and for other parts of the building, as well as for broken glass, broken lighting fixtures, etc., always make up a considerable sum on a building of even average size, especially if a series of accidents occurs on the job.

Specifications generally call for buildings to be left "broom clean" by the contractor. Sometimes, however, the specifications or some other part of the contract will require that every part of the building be left clean and polished and ready for occupancy, so that no further work of this kind will be necessary. In any case, a great amount of rubbish will have to be removed and considerable plain cleaning must be done. The work of gathering together a large assortment of miscellaneous waste material, crates, cans, broken glass, etc., and the removal of all this from the various floors of a building, besides the sweeping of the floors, account for one part of the cleaning cost. Another part covers the loading of the stuff on dump trucks and the hauling and disposal of it. A third part of this kind of expense may be necessary—that for washing all the window and door and other glass in the building. Then a fourth part that may have to be added is for cleaning the floors all over again and polishing them. Experienced estimators, knowing that a gang of men may be required for each of these operations for a number of days, take care to figure the cost accordingly.

**Surveys and engineering** and other special services are frequently specified to be furnished by the contractor; and he may find these desirable, even though they are not specifically called for in his contract. If they are not included under some other division of the estimate, they should be placed under the job-expense heading. Even the cost of accurately laying out the job and building and maintaining the batter boards must be considered. Special drafting work and the cost of blueprints, job signs, and progress photographs also come into this category. Figures 29 and 30 show the batter boards and lines on a simple job. After the corners of the building have been accurately determined, the lines running over them are extended to the batter boards where the reference

marks are maintained until the walls are built. Other reference lines are provided for on the batter boards, such as the line of the footings and the excavation line.

**Surety bonds, guarantees, deposits, etc.,** are general items of job cost. The cost of a surety bond may run as high as 2% of the total amount of the contract. The trouble of securing a bond and the time and expense of office work in connection with it all through the job and after the job is completed are elements of cost that some contractors seem to ignore completely; but these should be taken into account. Similarly, the trouble and expense incident to guaranteeing work may run for a year or more after the job is finally accepted. If any cash deposits are demanded,

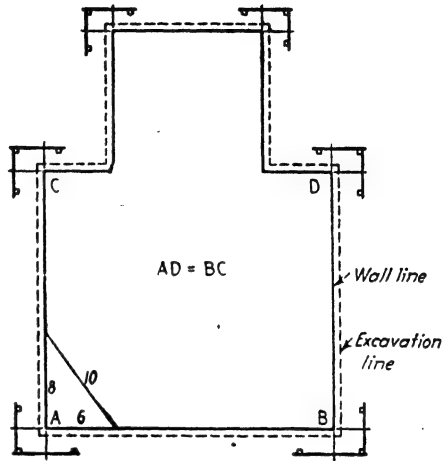


FIG. 29.—Batter boards and lines.

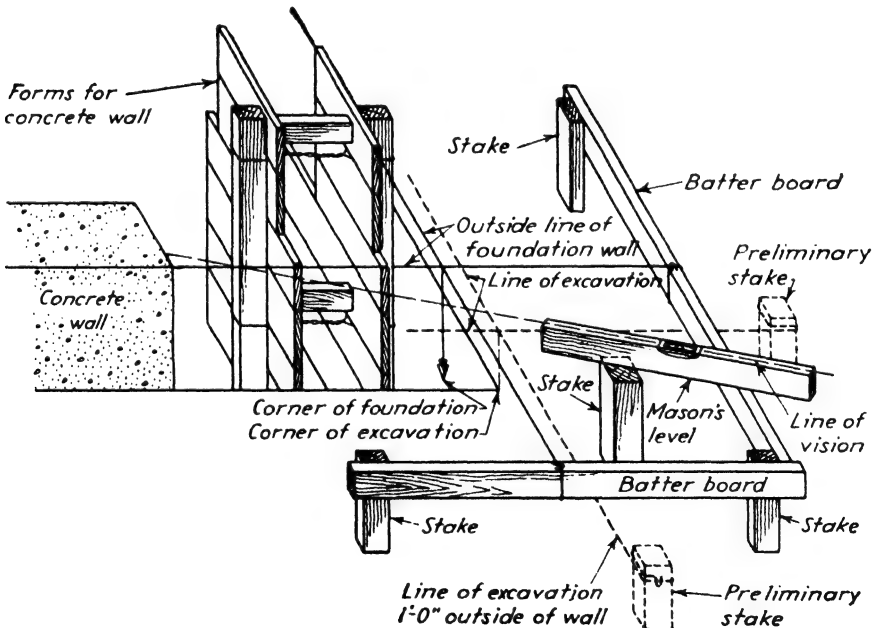


FIG. 30.—Batter boards and lines.

or if any money is to be held for a length of time, the wise estimator will make careful note of each such item on his estimate sheets and will charge the proper amount of interest as a part of the cost. He

will also put in proper amounts for possible repairs, maintenance, etc., and service charges for the incidental trouble.

**Insurance** is a very considerable part of the cost of doing construction work. The proper place to put insurance costs that are based on labor is in each of the work divisions of the estimate and in the job expense division of the estimate, as well. In this way the various rates will best be taken into account. Some estimators, however, prefer to compute the total insurance requirements and then enter a lump sum of money, to cover it, in the job expense sheet or in the summary of the estimate. All the workmen and supervisors and other employees on the job are subject to some form of insurance that has to be paid for by the employer. This includes state workmen's compensation and unemployment insurance, Federal social security and old-age pension insurance, public liability insurance, and others. The total cost for these runs between 11% and 20% of the pay-roll amount for regular building work and much more for demolition, steel erection, and other specially hazardous lines of work. In addition to the insurance items that are based upon the pay roll, other insurance is usually carried by contractors, such as contingent insurance on the subcontractors, fire insurance, and automobile insurance. Definite entries must be made on the estimate sheets to cover every kind of insurance carried.

**State labor laws** cover the design, construction, and operation of factories, manufacturing plants, and mercantile establishments and include the work of constructing buildings. In New York the labor law is administered by the State Industrial Board and is enforced through the State Commissioner of Labor and the usual channels of law enforcement. This commissioner also administers the Workmen's Compensation Law.

In the supervision of places where people work, the proper sanitation of these places is included, and they are controlled for guarding against and minimizing fire hazards, personal injuries, and diseases. It is the policy and intent of the law that all places to which it applies shall be so constructed, equipped, arranged, operated, and conducted in all respects as to provide reasonable and adequate protection to the lives, health, and safety of all persons employed in them.

On building construction work, inspectors from the Labor Department make careful note of the scaffolding, ropes, planks, ladders, hoistways, temporary protection, and equipment; and it is against the law for any contractor, superintendent, foreman, or anybody else who directs work in any way to allow workmen to be endangered.

In steel-frame construction, the entire floor framing must be planked over on the floor where the steel erectors are working. Floor arches of concrete or some other material must be installed as the building pro-

gresses and, in wood-floor construction, the underflooring must be likewise installed as the building progresses. If double wood floors are not used, the floor below the one being worked on must be planked over. Elevator shafts and hoistways must be fenced in at each floor. All persons are prohibited from riding on any platform hoist or on any elevator car that is not equipped and operated for carrying passengers; and all persons are forbidden to ride on any concrete bucket, derrick, or other hoisting apparatus or on loads being hoisted.

All factories must be registered and are inspected periodically. They must have fire drills. All halls, stairs, elevators, etc., must be kept lighted during working hours; proper safeguards must be maintained at all elevators, hoistways, etc.; and toilets must be kept clean and in good working order. Estimators should realize that these requirements, with the exception of the fire drills, also apply to construction jobs and that the cost involved has to be provided for in their estimates.

**Few contractors** and almost no architects appreciate the amount of indirect expense involved in changes that are ordered while a job is in progress. Sometimes this work should have been included in the specifications, and the extra work thus made necessary is due to the oversight or lack of experience of the architect. When such items come up, the architect may have an impulse to cover them up rather than to make a straightforward explanation to the owner. In that case, work is done for the owner without his paying anything for it.

Some architects will tell the owner, and really believe it to be true, that their specifications and plans are so definite and binding that all bids may be judged by the figures alone. This is a fallacy, in spite of the assumption that none but first-class contractors are allowed to figure the job.

Certain speculative operators have been known to swindle their contractors and subcontractors by having them estimate on incomplete specifications, certain pages being temporarily removed. Happily, however, this is not at all a common occurrence.

Contractors should be asked to estimate only when a full set of properly prepared plans and properly written specifications are put at their disposal for an ample length of time to serve this purpose. Furthermore, no alternate prices or unit prices should be asked for, nor should any addenda be issued, until after the bids have been submitted and at least half of the bidders have been eliminated.

**A summary** enables the estimator and the contractor to see quickly the relation and the proportions of the various branches of the work. This is valuable as a general check on the amounts extended, and it also serves as a basis for determining the office overhead and the profit. One danger in summarizing an estimate, however, is that some of the totals

SUMMARY OF ESTIMATE

STORE AND SHOWROOM BUILDING.

Submitted

Webster Ave. &amp; 188th St.

April 1, 1945.

Owner: Mayfair Co.

Wells &amp; Brown, Archts.

|                              |                 |
|------------------------------|-----------------|
| General Job Expense          | \$ 3,480        |
| Excavating                   | 5,478           |
| Concrete Work                | 7,120           |
| Mason Work                   | 12,654          |
| Granite                      | 300             |
| Cast Stone                   | 1,050           |
| Structural Steel             | 12,200          |
| Miscellaneous Iron           | 675             |
| Concrete Floor & Roof Arches | 16,105          |
| Cement Finish Work           | 3,555           |
| Roofing & Sheet Metal        | 2,424           |
| Dampproofing                 | 265             |
| Caulking                     | 115             |
| Plastering                   | 4,937           |
| Carpentry                    | 2,681           |
| Kalamein Work                | 452             |
| Rolling Steel Doors          | 400             |
| Peelle Shaft Doors           | 600             |
| Overhead Garage Door         | 140             |
| Tile Work                    | 372             |
| Rubber Flooring              | 1,347           |
| Metal Toilet Partitions      | 110             |
| Finish Hardware              | 300             |
| Glass & Glazing              | 227             |
| Painting                     | 1,484           |
| Plumbing                     | 2,750           |
| Heating                      | 2,552           |
| Oil Burner                   | 800             |
| Electric                     | 1,670           |
| Elevator                     | 3,000           |
| Job Cost                     | 89,243          |
| Overhead 7%                  | 6,247           |
| Total Cost                   | 95,490          |
| Profit 4%                    | 3,820           |
| <b>BID</b>                   | <b>\$99,310</b> |

FIG. 31.—Summary of estimate.

| JOHN W. WILLIAMS CONSTRUCTION CO., Inc. |  |                      |      |                            |
|---|--|----------------------|------|----------------------------|
| BUILDERS                                |  |                      |      |                            |
| Job <u>Fordley Bldg.</u>                |  | 389 LEXINGTON AVENUE |      | Date <u>March 10, 1945</u> |
| <u>Syracuse, N. Y.</u>                  |  | NEW YORK CITY        |      | Est. No. <u>481</u>        |
| JOB EXPENSE                             |  |                      |      |                            |
|   | Superintendent-Asst. Supt.-Job Runner  | 15 wks.              | 100. | 1500                       |
|   | Engineers-Rodmen   | 15 wks.              | 75.  | 1125                       |
|   | Timekeepers-Checkers-Bookkeepers-Stenographer-Expeditors                           | 15 wks.              | 50.  | 750                        |
|   | Watchmen-Waterboys   | 12 wks.              | 51.  | 612                        |
|   | Temp. Office & Equipment 8' x 20'  |                      |      | 150                        |
|   | " Sheds-Cement Shed-Warehouse  |                      |      | 50                         |
|   | " Toilets  | 2                    | 20.  | 40                         |
|   | " Roads  |                      |      | —                          |
|   | " Light & Power  | 13 wks.              | 12.  | 156                        |
|   | " Water (Conn.-Piping-Protect-Water)   |                      |      | 75                         |
|   | " Lights-Guards-Barricades-Ladders-Stairs-Protection                               |                      |      | 100                        |
|   | " Doors-Windows  |                      |      | 25                         |
|   | " Fences   |                      |      | —                          |
|   | " Bridge-Lighting  |                      |      | —                          |
|   | " Heat   |                      |      | —                          |
|   | Travel & Transportation  |                      |      | 50                         |
|   | Trucking   |                      |      | 200                        |
|   | Telephone & Telegraph-Archts.  | 15 wks.              | 6.   | 90                         |
|   | Small Tools-Tarpaulins   |                      |      | 50                         |
|   | Plant & Equipment  |                      |      | 100                        |
|   | Plank & Horses   |                      |      | 200                        |
|   | Pumps & Pumping-Fuel-Attendance  | 4 days               | 20.  | 80                         |
|   | Surveys-Laying Out-Batter Boards   |                      |      | 40                         |
|   | Permits (Street-Building-Vault)  |                      |      | 20                         |
|   | Drafting-Shop Drawings-Blueprints  |                      |      | 100                        |
|   | Rubbish Removal-Cleaning-Final Cleaning  | 4800 SF              | .03  | 144                        |
|   | Clean Glass-Glass Breakage   |                      |      | 60                         |
|   | Protect Finish Floors-Stairs   |                      |      | 50                         |
|   | Cut & Patch  |                      |      | 250                        |
|   | Photographs-Samples-Tests-Guarantees   |                      |      | 180                        |
|   | Winter Conditions-Snow Removal   |                      |      | —                          |
|   | Hoist & Hoisting (Engine-Installed-Remove-Service-Fuel Tower-Platforms-Head-Cable) | 8 wks.               | 280. | 2240                       |
|   | Project Signs  |                      |      | —                          |
|   | Project Office (Light-Heat-Janitor-Equipment)                                      |                      |      | —                          |
|   | Contractors Reports  |                      |      | —                          |
|   |  |                      |      | 8417                       |

FIG. 32.—A job-expense sheet.

may not be carried over from the regular make-up sheets or that last-minute changes may be made in some of the items and the corresponding amounts may not be changed in the summary. For this reason, a check should be made by adding up all the individual sheets of the estimate separately from the summary, to see that this total agrees with that on the summary.

Many of the items in building work are sublet. Some estimators make up approximate estimates of their own for these items, as a check upon the prices received from subcontractors. These approximations should always be used only as a check, however, unless the estimator is thoroughly familiar with the work and with the pricing of the items thus figured. The custom is for contractors to send out to their regular group of subcontractors, postal-card requests for estimates, when the plans are first received. It is customary also for the successful contractor to favor those subcontractors whose figures were received before the contractor's bid was submitted and were used for arriving at the amounts entered in the summary of the bid. This is only fair, and subcontractors soon learn whether it is worth their while to continue to estimate for a particular contractor. The ideal condition—one that ethics demands—is that the lowest responsible bidders in all lines shall be given the work in their line without further question and without any changes in their prices.

Figure 31 shows a typical summary sheet of an estimate. The summary will also serve to illustrate a typical list of divisions, with the headings given in the usual order.

Figure 32 gives a typical general job expense sheet, from which the amount for the first item on the summary is obtained.

On the specimen estimate sheets, note the method of treating the main heading, the headings for the main divisions, and the subdivision, or key, headings. The main heading is placed on the summary and on the first sheet of the estimate only. Follow the neatness and general arrangement and the consistent order of the figures shown on all the sheets.

### Exercises

1. Name 10 items of expense that should be considered under the heading Job Expense.
2. What cleaning and rubbish-removal work are done on a building job and therefore require consideration as elements of cost?
3. What does an estimator need to know about insurance?
4. Name 10 items of expense that should be considered as included in the main office, or "overhead," expense.
5. Make a general job expense sheet for the house estimate.
6. Make a summary sheet for the house estimate.

## CHAPTER, X

### EXCAVATING

**Excavating** means digging holes. For building work this generally consists of digging a big hole, called the "main" excavation, and other parts, which are called "pit" excavation, "trench" excavation, etc. This big, odd-shaped hole is measured for the excavating portion of the estimate. To measure it in cubic yards, the three dimensions of each part are taken in feet; these, multiplied together, give cubic feet; and the result is divided by 27 to get cubic yards, because there are 27 cubic feet in one cubic yard.

Plans practically never show the outline of the excavation, nor do they generally indicate the ground level, or "original grade," of the site. It is necessary for the estimator to visit the place and determine the conditions that will affect the size of the required excavation. The outline of the banks of the excavation is then drawn on the cellar plan, and the profile of the excavation is drawn on one of the cross-sections. By this means the estimator is better enabled to visualize the actual work of doing the excavating.

**Space** must be allowed all around the outside of the structure for proper working room for installing the temporary forms for the footings and the walls. The projection of the footings beyond the outer face of the walls must be taken into account, as well as the natural sloping of the banks of the excavation.

The depth of the excavation is measured from the present, or "original," grade and not from the finished condition that may be indicated on the plans and sections. The deeper the excavation is to be made, the more thorough should be the study of the profile that the banks around the excavation will take—not only at the time the excavation is being dug but afterward, also. If a deep excavation is to be left open for several weeks or months, it will be necessary to provide bracing for the banks or else to make the excavation wide enough at the top so that earth washed down by rain or because of continual disturbance by working conditions will not hinder the proper construction of the foundations.

Pits and other handwork must be kept separate in the estimates, so that they may be figured at different prices from those for the main excavation. The main excavation work is usually done with a steam shovel or some other large piece of apparatus, unless the amount to be

removed is small or, for some other reason, the job does not warrant the use of large equipment.

**All items of expense** directly due to the excavating work are provided for under this heading. Temporary guardrails, ramps, and other provisions for doing the work safely and economically are noted in the estimate and considered in the unit cost per cubic yard for completely removing the excavated material, or else they are listed and priced separately.

Text and reference books refer to the "angle of repose" in connection with excavating. This is largely theoretical and has little practical value for builders. The angle is that which the bank of earth or other material makes with the horizontal without being held in place. Tables are given for reference, but a glance at the wide range of the figures in them will convince anybody of their worthlessness in accurate estimating. The only safe procedure is to know the locality well enough to be fairly sure of the probable ground conditions.

When soft banks are to be left standing, it is necessary to brace them or to drive sheeting for their support. This is called "skeleton" sheeting if only light bracing will suffice, or "sheet piling" if a continuous sheeting is required. Both need heavy wales and bracing to hold the sheeting in place. Ordinary wooden sheet piling consists of a continuous line of vertical planks held against the sides of the excavation by these horizontal timbers, called "wales" or "breast timbers," which are in turn supported by shores or by cross braces reaching to the opposite side of the excavation. Two-inch-thick planks are generally used for depths up to 12 feet and three-inch planks for depths up to 18 feet.

Isolated buildings of regular type, where only plain dirt excavation is to be considered, present no particular problem in estimating the costs under the Excavating heading. By allowing 18 inches of clear space all around the outside walls, the matter resolves itself into a case of care in measuring the plans and care in determining the present ground levels. The work is computed in cubic yards, as it is—in the ground—before being removed. If the work were priced loose or by the truckload, the natural expansion of the material would have to be considered.

Not enough care is given to estimating excavation work, especially where conditions are complex. Frequently it is necessary to install considerable temporary construction work before the excavating work may be completed. Rock excavation, ground water, adjoining buildings, and streets often make the work so complicated that the excavating becomes an engineering problem, requiring exhaustive research and planning. In the case of large buildings in New York City, there are many additional plan difficulties and operating handicaps, and only the most highly organized specialists in this field are capable of properly estimating the work and doing it. The excavating of rock under these

conditions and the removal of dirt and mud incidental to caisson work and pile driving are not ordinary estimating items.

In estimating for ordinary work, proper study should be made of the nature of the material to be removed, the general method of removal, special handling that may be necessary for topsoil or plants, temporary storage of material for later backfilling, method of disposal of the excess material, distance to the dump, cost of dumping, equipment and trucking costs, permits, protection of sidewalks and pavements, temporary roads and runways, ramps, safeguards, lights, watchmen, foremen, labor, compensation insurance, public liability insurance, employment and old-age pension insurance, general and overhead expense, risks, weather conditions, breakdowns, cave-ins, rehandling, etc.

In estimating for complex excavations, engineering skill is necessary and should be provided. Most excavations should be considered to be complex if they have rock or water to be cared for or if they are more than ten feet deep or if there are adjoining buildings in which the foundations do not extend down as far as the bottom level of the new excavation.

Excavations are always made deep enough to enable the foundations to be extended at least four feet below the finish grade, in order to escape the action of frost. At lower levels, soils are more condensed, also, and are less moist and will bear a greater load. Footings must be made wide enough not to exceed the bearing capacity of the ground. Rock, of course, in its native condition, will carry any load put upon it. In preparing a rock bottom, it is necessary to trim the rock to a level surface under all footings.

In soft ground, piles are sometimes driven on which to rest the foundations. Wood piles are used only where they will always be below the ground-water level; otherwise, they would soon rot away. Concrete piles are driven or are cast in place after a steel shell has first been driven.

**The site** should be visited by the estimator so that he may ascertain the type of ground, whether it is hard or soft, wet or dry, etc. The labor cost varies according to these conditions. The general method of doing the work must also be given consideration at the site—whether it shall be done by hand with picks and shovels, or by drag scrapers, steam or gasoline shovel, or some other means. Large equipment is used only when large amounts of work are to be done or when time is an essential element and high costs may be sustained in order to advance the date when actual construction can be started.

*Ordinary excavating* denotes the kind that can be done with shovels by hand, if this method is otherwise desirable. *Heavy earth* denotes clay or any other dense formation for which picks would be required before shoveling could be done. *Hardpan* denotes a tough formation of gravel that is held together with a natural cementing material and that cannot

practicably be loosened with an ordinary pick. *Rock excavating* is excavation of either solid rock or a formation of large boulders, which generally require blasting to break them up.

The cost of maintaining a shovel operated by steam or gasoline involves expense for fuel, repairs, depreciation, and the time required to move it to and from the job, as well as the pay-roll and incidental costs of the crew. A  $\frac{3}{4}$  cubic yard shovel can dig and load about 250 cubic yards of ordinary earth per day into trucks if there is free room for it to operate properly. In cramped quarters it will do much less.

Motor trucks carry from three to seven cubic yards per load, depending upon the capacity of the individual truck. Five cubic yards is the capacity of most of the trucks in general use. On very large operations, other equipment is often used, such as enormous "carry-alls" which cut into the ground and carry away 10 to 20 cubic yards at a time. Obviously, a job has to involve thousands of cubic yards in order that such large pieces of equipment can be operated economically.

The last material removed in an excavation is generally used for back-filling behind the foundation walls and elsewhere in those spaces that were excavated for working room in excess of the exact requirements for the structure itself. Sometimes this material may be taken directly from its original location and deposited where it is needed as backfill. This eliminates all extra handling, as well as the trucking costs and dump charges. Each job should be analyzed separately in order that this line of reasoning may be developed as it applies to the particular case.

Figure 33 shows a portion of an excavating estimate. Note the general method of separating the items for the purpose of computing the number of cubic yards in each part. Neatness and uniformity of arrangement of all the entries help toward the elimination of errors.

The kind of material to be removed will greatly affect the cost per cubic yard. Obviously, therefore, it is necessary to determine and note in the estimate whether the excavation is to be plain dirt, filled ground, sand, hard soil, or whatever the material to be removed may be. Often several kinds are found in one job and the computation of volumes and the pricing must then be adjusted accordingly.

The ground surface may be sloping or at various levels. In cases of this kind or cases where several materials are to be handled, it is necessary to divide the plot into as many small portions as will be necessary for computing the volumes and for grouping them so that the right unit prices may be applied.

**Costs.** A simple excavation, as for a suburban home, costs the contractor between 50¢ and 70¢ per cubic yard. This is for simply loosening ordinary dirt and spreading it over the balance of the plot with the aid of a drag scraper. Sometimes the rich topsoil is taken off

and piled up, to be spread carefully after the rough grading has been done.

|  |                   |  |  |    |   |   |   |   |           |
|--|-------------------|--|--|----|---|---|---|---|-----------|
| STORE & SHOWROOM BLDG., WEBSTER AVE. & 188 <sup>TH</sup> ST. |                   |  |  |    |   |   |   |   |           |
| MAYFAIR CO., OWNER • WELLS & BROWN, ARCHTS.                  |                   |  |  |    |   |   |   |   |           |
| <u>EXCAVATING (PLAIN DIRT)</u>                               |                   |  |  |    |   |   |   |   |           |
| <u>STEAM SHOVEL WORK</u><br>(HAUL TO DUMP)                   |                   |  |  |    |   |   |   |   |           |
| GENERAL  |                   |  |  |    |   |   |   |   |           |
| 90-0 x 88-0 x 9-3  |                   |  |  | 7  | 3 | 2 | 6 | 0 |           |
| Elev. shaft, etc.  |                   |  |  |    |   |   |   |   |           |
| 19-0 x 30-0 x 9-3  |                   |  |  |    | 5 | 2 | 7 | 3 |           |
|  |                   |  |  | 27 | 7 | 8 | 5 | 3 | 3         |
|  |                   |  |  |    | 2 | 9 | 0 | 9 | yd. 1.25  |
|  |                   |  |  |    |   |   |   |   | 3636      |
| <u>HAND WORK</u><br>(USE FOR BACKFILL)                       |                   |  |  |    |   |   |   |   |           |
| Col. ftgs.   |                   |  |  |    |   |   |   |   |           |
| 3  | 5-0 x 5-0 x 1-6   |  |  |    | 1 | 1 | 2 |   |           |
| 8  | 8-0 x 5-0 x 1-6   |  |  |    | 4 | 8 | 0 |   |           |
| 7  | 7-6 x 7-6 x 1-6   |  |  |    | 5 | 9 | 0 |   |           |
| 1  | 8-6 x 8-6 x 9-0   |  |  |    | 6 | 4 | 6 |   |           |
| 1  | 8-0 x 8-0 x 4-0   |  |  |    | 2 | 5 | 6 |   |           |
|  |                   |  |  | 27 | 2 | 0 | 8 | 4 |           |
|  |                   |  |  |    | 7 | 7 |   |   | yd. 1.50  |
|  |                   |  |  |    |   |   |   |   | 116       |
| WALL FTGS.   |                   |  |  |    |   |   |   |   |           |
| N  | 64-0 x 2-6 x 0-6  |  |  |    | 8 | 5 |   |   |           |
| S  | 64-0 x 3-0 x 0-6  |  |  |    | 9 | 6 |   |   |           |
| E  | 54-0 x 3-0 x 0-6  |  |  |    | 8 | 1 |   |   |           |
| W  | 55-0 x 3-0 x 0-6  |  |  |    | 8 | 3 |   |   |           |
|  |                   |  |  | 27 | 3 | 4 | 5 |   |           |
|  |                   |  |  |    | 1 | 3 |   |   | yd. 1.50  |
|  |                   |  |  |    |   |   |   |   | 20        |
| EXTENSION WALLS  |                   |  |  |    |   |   |   |   |           |
| E  | 57-0 x 3-0 x 10-0 |  |  |    | 1 | 7 | 1 | 0 |           |
| N  | 16-0 x 3-0 x 10-0 |  |  |    | 4 | 8 | 0 |   |           |
| S  | 16-0 x 3-6 x 10-0 |  |  |    | 5 | 6 | 0 |   |           |
|  |                   |  |  | 27 | 2 | 7 | 5 | 0 |           |
|  |                   |  |  |    | 1 | 0 | 2 |   | yd. 1.10  |
|  |                   |  |  |    |   |   |   |   | FWD. 3884 |

FIG. 33.—An excavating estimate.

An excavation for a building in the heart of the business section of a big city costs the contractor between \$2 and \$3 per cubic yard. This is for digging, loading, hauling, and disposing of the excavated dirt,

together with all the incidental expense of dumping charges, lost time, temporary protection, watchman's services, etc.

If there is rock or if the banks require bracing, the extra cost of such items will have to be computed separately. If they are considered in the cubic yard price, this may well amount to between \$6 and \$12 per cubic yard.

**Building codes** require that any person causing an excavation to be made must provide such sheet piling and bracing as may be necessary to prevent the earth of adjoining property from caving in before permanent supports have been provided for the sides of the excavation. Also, whenever provisions are lacking for the permanent support of the sides of an excavation, the person causing such excavation to be made must build a retaining wall at his own expense and on his own land. This retaining wall must be carried to such a height as to retain the adjoining earth. Often it is required to be properly coped and provided with a substantial guardrail or fence. Some codes also provide that whenever an excavation is carried to a depth of more than 10 feet below the curb level, the person causing it must preserve and protect the adjoining property and structures and provides shoring, underpinning, etc., if necessary, regardless of how far down the adjoining foundations may extend.

### Exercises

1. Why is the depth of an excavation measured from the original grade, instead of from the finish grade that can be seen on the architect's elevations?
2. About how much extra space is required around the outside of the walls below grade for the proper construction of them? Show by a sketch.
3. Compute the amount of excavating in the following portions of an excavation:
  - a.  $109'0'' \times 86'0'' \times 12'0''$
  - b.  $22'6'' \times 14'8'' \times 10'9''$
  - c.  $146'0'' \times 4'0'' \times 3'2''$
4. Write at least 300 words of notes on excavating work, taken from one or two of the books listed in the Preface. Name the books used.
5. State the meaning and use of the following terms, and give sketches if possible: building line, topsoil, backfill, sheet piling.
6. Make a complete estimate of the excavating work required for the house shown in Chap. V. Assume that the material is ordinary earth with 6" of topsoil, and that the present grade is level and is 4" below the level of the finish floor. The specifications are essentially as follows:

Excavate for all footings, foundation walls, areas, steps, walks, and driveway, first carefully removing and stacking all the topsoil in the areas to be excavated. Excavate for a sufficient distance from foundation walls to allow for inspection and to permit the various trades to install their work.

Fill under platforms and garage floor and backfill against foundation walls with clean dirt or gravel taken from the excavation, and consolidate this with water by puddling. The spaces shall first be cleaned out and no trash shall be allowed to be used.

The topsoil and excess excavated material shall be left stacked on the premises where directed. The finish grading and landscaping will be done under a separate contract.

## CHAPTER XI

### CONCRETE FOUNDATIONS

Concrete and cement work is usually divided into several parts for convenience in estimating. Sometimes all the work is placed under one heading, but for regular buildings portions are separately listed under such headings as Concrete Arches and Cement Finish.

The general method is to list the different items in each division approximately in the same order as that in which they will be constructed. Take the footings in the present division and complete them before proceeding to the next item to be listed under Concrete Foundations.

Include all the forms, reinforcing steel, and concrete in each item--if the item requires all three parts.

Adopt a fairly uniform procedure when listing quantities for any kind of work. Follow a regular system also when putting down the dimensions: length first, width or thickness next, and then height. This is a custom, and it makes the figures easier to identify—at least, to some extent. Separate all the work into small items or groups for ease in checking and pricing.

Put under this heading, Concrete Foundations, all the wall and column footings, cellar or basement walls, area walls, pits, boiler and tank foundations, and all other items of bulk concrete below the first floor. Omit the cellar or basement floors and all other pavements, however, as these would undoubtedly be installed much later than the other work mentioned and should, therefore, be listed with work done at the later period. It is customary to list floors, walks, and other pavements that are laid directly on earth under the heading Cement Finish.

Some estimators measure all the concrete shown on the plans, then all the formwork and all the reinforcing, separately. This method may seem concise and systematic because it keeps each of these three parts by itself. A better method, however, is to complete each item shown on the plan before going to the next. Start with the footings, as first stated, and list all the forms, reinforcing, and concrete for one kind of footing, such as the column footings; then take another kind of footing, such as the main-wall footings, and list all the forms, reinforcing, and concrete in these. Put a minor heading before each item of work thus handled and proceed in the same manner with the main walls, inside walls, area walls, etc., completing each one before considering the next.

This method is better because it has been found that fewer errors of omission and computation are made when it is used. It is better, too, because it enables the estimator to keep the work in groups that are complete in themselves. This is important in the later analysis of the construction details, in the analysis of the unit costs, and in making adjustments in the estimate.

All the work is estimated complete, in place, and the price thus includes all the material, labor, use of equipment, and incidental direct expense of every description. Each of the three parts of each item of work is listed and priced separately: the forms, the reinforcing steel, and the concrete. If no reinforcing steel is called for, this part is omitted or a note is inserted to the effect that none is required.

*The formwork* is priced per square foot of contact of the forms against the concrete.

*The reinforcing steel* is priced per pound of steel. The number of linear feet of each size of bar called for is listed, and then, from this information, the weight is computed.

*The concrete* is priced per cubic yard. Each different mixture is kept separate in the estimate, so that different prices may be applied.

Each portion of the concrete shown on the plan is, then, first given a minor heading in the estimate. It is next subdivided under the headings, Forms, Reinforcing (when the item calls for reinforcing to be provided), and Concrete.

The forms are totaled in square feet for each of these minor headings and are later priced at the contractor's cost per square foot. Where reinforcing bars are called for, they are totaled in linear feet of each size, in each minor heading, and these are turned into pounds ready to be priced at the contractor's cost, per pound, complete in place. The concrete is likewise totaled, first in cubic feet and then in cubic yards, ready to be priced at the contractor's cost per cubic yard.

**Formwork.** Forms must be strong and rigid, and they must be well braced to prevent bulging. Wall forms have to resist a pressure of about 145 lb. per sq. ft. for each foot of height, to hold wet concrete. At the same time, however, forms must be so arranged that they may be rapidly put in place and readily taken apart for re-use.

Temporary forms are used to hold the wet concrete until it has set sufficiently to allow removal of the forms safely. For ordinary walls forms may be removed in about two days, but for beams and floor slabs a week or more is required. The forms are used over again for other parts of the construction, where possible. Great care is taken in the construction of the forms so that the exact shape of the concrete will be formed and so that they will safely hold the great load entailed by wet concrete and the shocks of working conditions.

Forms should always be used for footings, except in extreme cases where it can be plainly seen that they may profitably be omitted. Most specifications call for forms to be used for footings. When the excavating is very hard and the banks will stand without any caving in, even after a rainfall, then the excavation for the footings may be cut neat to the line of the concrete footings (if permitted by the specifications) and the trench thus formed filled to make a footing. If it is necessary to excavate within the building after the footings are thus formed, in order to place the floor or the base under the floor, it will probably not be worth while to consider omitting the footing forms. Footing forms are quite simple. If they are omitted, considerable extra time is consumed in trimming the trench sides very neat, and some of the concrete will undoubtedly be wasted. Furthermore, if space is needed outside the walls anyway, for easier installation of the wall forms or for waterproofing the walls or installing outside drains, etc., then surely the method of omitting the footing forms would seem uneconomical.

It is obvious that forms for walls and wall footings will not cost the same price per square foot of contact as forms for column footings and other isolated items. There is no direct relation between the quantity of forms and the quantity of concrete, either. Every difference in the size and shape of the concrete to be constructed will make a change in the quantity or type of forms required. This is another reason for adopting the method recommended for estimating concrete work, so that the various kinds of formwork may be kept properly separated and be priced differently where the character of the work in the items calls for different prices.

Wall forms are removed within two or three days after the pouring of the concrete is completed in them; but thin walls in winter are allowed at least five days. Ordinary floor and roof slab forms are stripped in six or seven days in summer and two weeks in winter. Beams and girders require about two weeks in summer and four weeks in winter. Columns require two days in summer and four days in winter. Girders and slabs should be shored as the forms are being removed, and left supported for several days longer.

Several factors enter into the cost of formwork, not the least of these being the possible re-use of the lumber or of made-up panels, or, as in the case of column footings, of the entire form box. Besides, it may be that not all the wall forms on a job will take the same unit price, because one series of walls may require more bracing than others or the lumber in one may not be available for further use afterward.

The square feet of contact area of the forms against the concrete is found by measuring, on the plans, the concrete surfaces that will require this temporary support. The dimensions of each item are

entered in some suitable order on the estimate sheets in feet and inches, and the total square feet extended for each part, or for each group, when a group can readily be made.

**Joints.** Because it is usually not known just where each pouring of concrete will end, to figure the number and type of construction joints that will be required is impossible. However, in every concrete estimate an item should be entered for construction joints, and an approximation should be made as to the number of them and the average price cost of each one or the cost per lineal foot shown. Also, if dowels or special treatment of the joints are specified or required for proper bonding of the new concrete to the old work, these must, of course, be taken into account, either by figuring in detail the work involved or at least by entering an approximation of the total cost expected to be incurred.

Expansion joints are often specified or shown on the plans. These require study as to their requirements of material and labor. They are usually priced on the basis of the linear foot of joint for regular joints, or by the price per joint for special or elaborate joints.

**Inserts.** Piping for plumbing, heating, and electric lines running through concrete walls and floors requires some work on the part of the concrete gang or of the carpenters installing the forms. Anchors for structural steel and for securing several kinds of materials used by other trades must be installed in the concrete, and inserts of various kinds that are employed in building work are built into the concrete. These should all be counted by the estimator and priced properly under the heading Concrete Work for the labor of installing and bracing them and, if required, for the cost of the item or material that is so built in. Anchors, especially, must be given care in order that they may project at just the right locations and at the right distance from the face of the concrete. Sometimes two carpenters will spend an hour properly placing a single anchor in the forms. This would mean a cost of about \$4 for each such anchor, to cover the labor and insurance, or about \$5 each as the total charge that would be made to the owner if the general expense, overhead, and profit items are considered (as, of course, they should be if one is considering the effect an item has on the contract amount). Thus, if there were 50 such anchors required and they were forgotten in the estimate, the bid for the job would be about \$250 lower than it should be, on this one item alone.

**Concrete.** The number of cubic yards of concrete is obtained by measuring the concrete indicated on the plans. The dimensions for this are carefully entered and computed to get cubic feet for each entry and then totaled in cubic feet for the entire item being considered. Before this is extended into the final column, it is divided by 27 to turn it into cubic yards, and this amount is extended for pricing.

Many estimators leave their concrete items in cubic feet instead of turning them into cubic yards as was formerly the universal custom. Even these, however, usually turn the figures into cubic yards for figuring such items as runways and for progress-schedule entries, etc. So little saving in written work and mental effort is involved that it seems hardly worth while to vary from the custom used by most contractors, that of considering concrete in cubic yards for all purposes.

Freshly poured concrete should be worked around in the forms so as to compact the mass before it begins to set and to remove any air pockets that may otherwise form in the concrete. This is done by pushing iron or wood rods down into the concrete and churning it about, or by using special tools or mechanical agitators that are available for this purpose. Specifications for good work require that this shall be done and also call for the tamping or ramming of concrete that is poured on the ground to form pavements, etc. The unit price for concrete work should be increased to take care of this expense, if it is called for, or a separate entry should be made in the estimate to cover it. Concrete begins to "set" about 30 minutes after being poured and should not be disturbed in any way after that time until it is thoroughly set. In fact, it should be protected against disturbance.

Concrete is made by mixing cement and sand with a coarser material, called the "coarse aggregate." Sand is called the "fine aggregate." The coarse aggregate is usually either coarse gravel or crushed stone, except in lightweight floor and roof arches, where cinders are used instead. Steel bars or wire mesh are embedded in the concrete when tensile strength is necessary as in beams, girders, floor arches, etc. When it has any form of reinforcing, concrete is called "reinforced concrete." Without reinforcing, it is called "plain concrete."

For ordinary work the concrete mix is generally proportioned by specifying the volume of each of the ingredients to be used. For example, a 1:2:4 concrete means one made of 1 part of cement, 2 parts of sand, and 4 parts of coarse aggregate. The coarse aggregate is mentioned by name. For work of any importance, it is now the practice to specify the strength of concrete desired, instead of the proportions of the mix: for example, 2,500-lb. concrete, 3,750-lb. concrete. This means that the concrete must have the strength specified, per square inch, after 28 days—the period generally accepted as the complete curing period for concrete. Most concrete is bought ready-mixed and the companies supplying it have accurate measuring devices at their plants to produce the concrete desired.

The mixtures of concrete that are generally used form concrete with a compressive strength of between 2,500 and 3,750 lb. per sq. in. The strength depends upon the proportion of cement, mainly, and on the

amount of water included, the quality of the workmanship, and other factors. Important work must be given constant supervision by the superintendent, the concrete foreman, the carpenter foreman (as to the formwork), the reinforcing foreman, and the job engineer. This means that important concrete will cost much more for the general job expense as well as for the actual higher cost of the concrete ingredients, if a richer mix is called for, and for more lumber and labor required for forms that are better made than the ordinary. On a job of reinforced concrete with very rigid requirements, the complete structure may cost 50% more than on one of ordinary type.

In concrete, between 6 and 7 gallons of water is required for each bag of cement used. Thus, if six bags of cement are used per cubic yard of concrete, between 36 and 42 gal. of water is needed for the cubic yard of concrete. This is a considerable amount of water and, if the concrete is mixed at the job, adequate provision must be made for obtaining the water and supplying it at the point of mixing. In some localities a meter must be installed; and the water must be paid for. These are items of expense that the estimator must provide for in the estimate, wherever they are required. If long lines of temporary water piping have to be installed and maintained, especially in winter weather, the expense will be considerable.

The chemical action between the cement and water used in concrete is what causes the hardening, or setting, of concrete. This is a slow process, which continues for months. If the concrete is allowed to dry out too quickly, it does not gain its full strength; therefore, specifications frequently ask that special attention be given to slowing up the drying process, or "curing" the concrete. This is done particularly in the case of concrete floors. Material to mix with the concrete or to apply on it after it is poured is sometimes called for. Whatever the case, it is the concern of the estimator to figure the cost involved and to provide for it in his estimate.

**Reinforcing Steel.** The amount of reinforcing steel rods is obtained by listing the number of rods of each size and length required. Reference to the specifications and to the notes on the plans may be necessary in order to find some of this information. The total length in linear feet of each size is computed from the entries thus made in the estimate, and this figure is multiplied by the number of pounds that the rod (or square bar) weighs per linear foot. This unit weight is sometimes given on the plans or in the specifications, but more often it is not and must be looked up in a steel handbook or in one of the standard builders' reference books. The total weight of steel is extended for each item or for each group of similar items. Note that pieces of square cross section are called "bars" and those of round cross section are called "rods"; however, these two terms are applied loosely to mean either kind.

Round rods come in  $\frac{1}{4}$ ",  $\frac{3}{8}$ ",  $\frac{1}{2}$ ",  $\frac{5}{8}$ ",  $\frac{3}{4}$ ",  $\frac{7}{8}$ ", and 1" diameters. Square bars come in  $\frac{1}{2}$ ", 1",  $1\frac{1}{8}$ " and  $1\frac{1}{4}$ " sizes. Although these are the sizes most used, there are others not in common use.

| CONCRETE                       |                        |  |  |  |  |                 |     |     |          |
|--------------------------------|------------------------|--|--|--|--|-----------------|-----|-----|----------|
| MAIN WALL FTGS.                |                        |  |  |  |  |                 |     |     |          |
| Forms                          |                        |  |  |  |  |                 |     |     |          |
| W.                             | 2 x 59'-0" x 1'-0"     |  |  |  |  | 118             |     |     |          |
| N.                             | 2 x 84-0 x 1-0         |  |  |  |  | 168             |     |     |          |
| S.                             | 2 x 82-0 x 1-0         |  |  |  |  | 164             |     |     |          |
| E.                             | 2 x 59-0 x 1-0         |  |  |  |  | 118             |     |     |          |
| E.                             | 2 x 79-0 x 1-0         |  |  |  |  | 158             |     |     |          |
|                                |                        |  |  |  |  | 726             | φ   | .10 | 73       |
| Reinfg. $\frac{5}{8}$ " φ      |                        |  |  |  |  |                 |     |     |          |
| W.                             | 7 x 59'-0"             |  |  |  |  | 413             |     |     |          |
| N.                             | 5 x 84-0               |  |  |  |  | 420             |     |     |          |
| S.                             | 7 x 82-0               |  |  |  |  | 574             |     |     |          |
| E.                             | 7 x 59-0               |  |  |  |  | 413             |     |     |          |
| E.                             | 5 x 79-0               |  |  |  |  | 395             |     |     |          |
|                                |                        |  |  |  |  | 2215'           |     |     |          |
|                                |                        |  |  |  |  | x 1.04          | *   |     |          |
|                                |                        |  |  |  |  | 2304            | *   | .04 | 92       |
| Ties $\frac{3}{8}$ φ           |                        |  |  |  |  |                 |     |     |          |
| W.                             | 45 x 2'-4"             |  |  |  |  | 105             |     |     |          |
| N.                             | 63 x 1-10              |  |  |  |  | 113             |     |     |          |
| S.                             | 62 x 2-4               |  |  |  |  | 145             |     |     |          |
| E.                             | 45 x 2-4               |  |  |  |  | 105             |     |     |          |
| E.                             | 60 x 1-10              |  |  |  |  | 108             |     |     |          |
|                                |                        |  |  |  |  | 576'            |     |     |          |
|                                |                        |  |  |  |  | x .375          | *   |     |          |
|                                |                        |  |  |  |  | 216             | *   | .07 | 13       |
| Concrete $1\frac{1}{2}$ :5 St. |                        |  |  |  |  |                 |     |     |          |
| W.                             | 59'-0" x 2'-4" x 1'-0" |  |  |  |  | 138             |     |     |          |
| N.                             | 84-0 x 1-10 x 1-0      |  |  |  |  | 154             |     |     |          |
| S.                             | 82-0 x 2-4 x 1-0       |  |  |  |  | 191             |     |     |          |
| E.                             | 59-0 x 2-4 x 1-0       |  |  |  |  | 138             |     |     |          |
| E.                             | 79-0 x 1-10 x 1-0      |  |  |  |  | 145             |     |     |          |
|                                |                        |  |  |  |  | 271             | 766 |     | 268      |
|                                |                        |  |  |  |  | 28 1/2 yds. 944 |     |     | FWD. 446 |

FIG. 34.—A concrete estimate.

Wire mesh, square or triangular, is made of wire of several gauges, sometimes two gauges being used in one make of mesh. The intersections are generally welded. Mesh is measured by finding the number

of square feet of area to be covered and adding 10% for the laps. The gauge and spacing of the wires or the weight per square foot must be stated in the estimate.

The next chapter, dealing with reinforced-concrete construction, contains numerous illustrations of formwork, reinforcing, and methods of construction that are applicable also to concrete-foundation work.

A specification may call for the reinforcing steel rods to be tied at every intersection. This is somewhat different from one requiring merely that enough intersections shall be tied to keep the rods in proper position. The tie wire has no value as reinforcing. If rods are placed a few inches apart, two ways, there will be a great many intersections, and the time required for tying may be four or five times that for plain tying. An experienced estimator notices this in specifications and gauges his pricing accordingly. He may not take written notes of such deviations from the usual run of work, but they all tend to set his mind for the pricing range he is going to use—a low range for jobs that have liberal specifications and higher ranges for those of more rigid requirements. A wise estimator will not assume too much liberalization of vaguely written specifications, as he may be surprised later to learn that an inspector on the job for the architect is of the type accustomed to rigid specifications, and it may be embarrassing to keep differing from him regarding the interpretation of the requirements.

Figure 34 gives the method of entering concrete items in the estimate. The job used here called for cross rods to act as ties. As these are similar to reinforcing rods, they are listed along with the reinforcing rods.

**Form Material.** Form boards are generally  $\frac{7}{8}$ " thick, and widths of 6" to 10" are used. Bracing lumber is 2"  $\times$  4", 3"  $\times$  4", 4"  $\times$  4", 2"  $\times$  6", etc. The amount of lumber required for formwork, when the material is used but once, varies from  $1\frac{1}{2}$  to  $3\frac{1}{2}$  board feet per square foot of form contact. Nails used are 6d, 8d, and 10d mostly, and about 8 lb. are required for 100 sq. ft. of forms. Tie wire used is No. 8, No. 10, and No. 12 black annealed wire, and about 5 lb. are required for 100 sq. ft. of forms. This wire comes in bundles of 100 lb. The three sizes equal about 14, 20, and 33 feet, respectively, per pound. Nails come in 100-lb. kegs.

**Cement.** Cement comes in bags of 94 lb. each. A bag counts as 1 cubic foot of volume in mixing. Four bags make a barrel, although there is no barrel actually concerned.

**Aggregate.** Sand, called "fine aggregate," weighs about 2,700 lb. per cu. yd. Gravel also weighs about 2,700 lb. and broken stone about 2,600 lb. per cu. yd. Gravel and broken stone are the two most commonly used coarse aggregates. In New York these commodities are sold by the cubic yard, but in some other sections the ton is the unit.

Gravel and stone are graded as to the size of a ring that each piece will pass through. Thus,  $\frac{3}{4}$ " gravel is the size that will pass through a ring  $\frac{3}{4}$ " in diameter. All coarse aggregate is more than  $\frac{1}{4}$ " in size; sand is  $\frac{1}{4}$ " or less in size. Clean cinders from hard coal, which are used in cinder concrete, are sold by the cubic yard.

**Reinforcing Rods.** The weight of rods and bars per linear foot is given in the following table.

| Size, in.      | Weight, lb. |            |
|----------------|-------------|------------|
|                | Round rod   | Square bar |
| $\frac{3}{8}$  | 0.37        | 0.48       |
| $\frac{1}{2}$  | 0.67        | 0.85       |
| $\frac{5}{8}$  | 1.04        | 1.33       |
| $\frac{3}{4}$  | 1.50        | 1.91       |
| 1              | 2.67        | 3.40       |
| $1\frac{1}{8}$ | 3.38        | 4.30       |
| $1\frac{1}{4}$ | 4.17        | 5.31       |

**Costs.** Formwork usually costs the contractor between 10¢ and 20¢ per square foot of contact. The cost will depend upon the quantity of work involved, the type of structure, the re-use of the form material, etc.

Reinforcing steel cost 4¢ to 8¢ per pound in the regular types of footings and walls, the cost depending upon the amount of work, the bending required, the number of intersections to be tied, etc.

Concrete costs between \$7.50 and \$14.00 per cubic yard, depending especially upon the mix required, as well as on the quantity of work and other factors.

Material quotations must be examined carefully before being used, especially those that are much lower than others for the same kind of material. Often the firms quoting do not know exactly what is called for in the specifications and will submit prices anyway, in order to get their names before the bidders on a particular job. In these cases the quotations usually state exactly what the vendor proposes to furnish, and it is a simple matter to check with the specifications to make sure that the requirements are met. There may be a difference in the size of the material, in the cases of the low quotation and those that are higher. This may cause the contractor who uses the low prices more expense in handling the materials, or the sizes proposed may not satisfy the architect. There may be a difference in the manner of shipment, the low quotation perhaps providing for shipments in large lots or by freight instead of directly to the job by truck.

Temporary runways are usually required for the concrete work. Total the number of cubic yards of concrete that are to be poured and place a price per cubic yard to take care of these runways, unless the unit price for the concrete has been raised enough to include the runways. A price of 25¢ to 30¢ per cubic yard will take care of the expense for the material and for installing, maintaining, shifting, and removing the runways, but will not include the incidental insurance costs.

Cement stored at the job for making concrete or mortar must be protected against dampness. On a job of any considerable size, a weather-tight shanty is usually built, to be used exclusively for this purpose. On smaller jobs or where the cement is to be stored for only a few days at a time, tight covering with tarpaulins will suffice. Even this requires material and labor, however, and it is a question whether it would not be better to construct a shanty in the first place rather than to be placing and removing covers every day and perhaps ruining the material used for this purpose. In addition, storms may reach cement that is protected by covers not properly tied down, and thus a whole pile of cement may be ruined.

When items of temporary protection, such as cement and some other materials entail, are left for consideration under the general job expense heading, they frequently are not given sufficient study. It is well therefore, to list all these items on the various work-division sheets for each trade, as well as on the general expense sheet. In this way, the items will probably be given the consideration they should have.

Foremen and other supervisory employees should be listed on all the work sheets. Even if they are not priced, the expenses thus noted will be brought out for consideration; and those contractors who price their work complete (including the foremen's time in the unit cost) may reconsider some of the unit prices or enter an amount to take care of additional expense in this regard, which they might otherwise overlook. Similarly, the unloading and stacking and protection of all materials should be listed. If large lots of material are received and must be stored for a length of time, considerable expense is incurred over and above the cost of materials that are brought directly into the work and used without further handling.

**Building codes** contain provisions for concrete construction. Forms must conform to the shape, lines, and dimensions of the members as called for on the plans. They must be substantial and sufficiently tight to prevent leakage. They must be properly braced or tied together, so as to maintain position and shape and ensure safety to workmen and passers-by.

The removal of forms must be carried out in such a way as to ensure the complete safety of the structure. Where the structure as a whole is

supported on shores, the vertical forms may be removed within 24 hours. The other forms and the shoring must be kept in place until the concrete has acquired sufficient strength to support its weight and the load upon it.

Metal reinforcement must be accurately placed and secured and must be supported by concrete or metal chairs or spacers or metal hangers. It must be protected by at least  $\frac{3}{4}$ " concrete in walls and slabs,  $1\frac{1}{2}$ " in beams and girders, and 2" in columns. In footings the reinforcing is usually required to have a minimum covering of concrete 3" thick. Splices in reinforcing rods or bars must usually be eighty times the diameter in length, and the ends of rods and stirrups must be well anchored.

Greater care is now demanded by architects in regard to the manufacture and placing of concrete. The concrete must be properly proportioned and properly poured; forms must be substantial. In general, concrete is receiving more attention than it formerly did. All this tends to slow up the progress of the job from the contractor's standpoint, and the rigidity of the inspection must, therefore, be considered by the estimator.

Concrete work requires equipment of good quality. As it is heavy work, the wheelbarrows, runways, chutes, bar benders, tampers, etc., must be extra strong in order to withstand the rough use they receive.

In the mixture of concrete, as the student should realize, the sand, cement, and water fill in the spaces between the pieces of broken stone or gravel or other material that forms the coarse aggregate. More than one cubic yard of materials, therefore, is required to produce a cubic yard of mixed concrete. For example, in a 1:2:4 mix, six bags (equaling 6 cubic feet) of cement, 12 cubic feet of sand, and 24 cubic feet of coarse aggregate are required, as well as about 6 cubic feet of water. Separately, these total 48 cubic feet, but when mixed together they fill a space of only 27 cubic feet, or one cubic yard.

The expression 1:2:4 means 1 part of cement to 2 parts of sand to 4 parts of the coarse aggregate, measured separately and dry. One bag of cement measures about a cubic foot and is always taken as one cubic foot. Note that the coarse aggregate measures almost a cubic yard, by itself, for each cubic yard of concrete produced. It is the spaces between the particles that furnish room for the other ingredients. However, concrete is spoken of and ordered as so many cubic yards of concrete in the structure or member of the structure under consideration.

### Exercises

1. Name the materials used in concrete work.
2. What parts of a building are generally estimated under the heading, Concrete Foundations?
3. By what units of measure are formwork, reinforcing rods, and concrete priced?

4. Compute the amount of concrete in the following walls:
  - a.  $132'0'' \times 12'6'' \times 1'4''$
  - b.  $47'8'' \times 13'9'' \times 2'2''$
  - c.  $22'9'' \times 6'2'' \times 1'0''$
  - d.  $34'3'' \times 10'4'' \times 1'3''$
5. What is meant by 1:2:4 concrete? 3,750-lb. concrete?
6. State average cost prices for the following kinds of work, in place:
  - a. Forms for foundation walls
  - b. Concrete in foundation walls
  - c. Reinforcing rods
7. Write at least 300 words of notes on concrete foundations, from two or three of the books listed in the Preface. Name the books used.
8. State the meaning and use of the following terms, and give sketches where possible: footings, wall forms, reinforcing rods, coarse aggregate.
9. Make a complete estimate of the concrete foundations for the house shown in Chap. V. The specifications state as follows:

All footings shall be 1:2:4 crushed rock or gravel concrete, poured into substantial forms. All main wall footings shall contain three continuous lines of  $\frac{5}{8}''$  diameter rods held in alignment by  $\frac{3}{8}''$  diameter rods every 18". The column footings shall be 16" thick and each shall contain four  $\frac{5}{8}''$  diameter rods in each direction, a total of eight rods in each footing. All rods shall be spaced as directed by architect.

All other concrete shall be 1:2½:5 crushed rock or gravel concrete, and all exposed surfaces, both interior and exterior, shall be rubbed smooth with carborundum stone.

## CHAPTER XII

### CONCRETE FLOORS AND ROOFS

Some estimators set up two separate headings, one for the concrete floor and roof construction and one for the cement work. On small jobs this is not necessary but on larger jobs it offers a better opportunity for analyzing the cost of the items included in these two lines.

**Concrete arches** is the term used to denote the type of floor and roof construction commonly found in steel frame buildings. The construction consists of cinder-concrete slabs, reinforced with heavy wire mesh, which are supported by the steel beams and girders. It is this heavy woven-steel cloth that carries the load—much as the steel cables carry the load on a suspension bridge. The steel beams and girders are encased in the

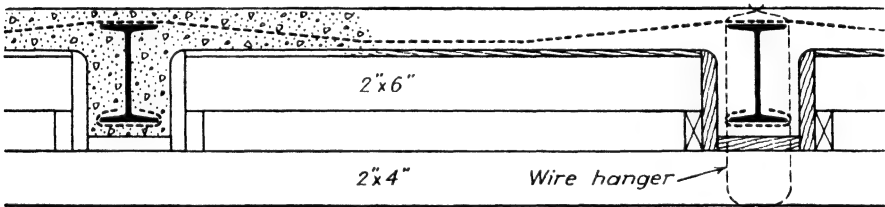


FIG. 35.—Concrete arches.

cinder concrete at the time the slabs are poured. This bonds the whole steel frame and the concrete floors and roof together. The concrete also protects the steel from fire, for, as one should know, steel will fail if exposed to extreme heat. Special wire wrappings, called “soffit clips,” are first placed around the bottom flanges of the beams and girders in order to bond the concrete to the steel.

All the temporary formwork, or centering, and the shores or braces that support the forms from below, or the hangers that support the forms from the steel beams over them, are included under this heading. The method of support is optional with the contractor. Generally speaking, hanging the forms from the steel beams and girders is found to be economical. In other types of concrete floor and roof construction, however, it is more desirable to jack up the formwork from below. Lumber used in formwork of this kind is always used many times over.

The fill that is placed on the slabs, between the slab (arches) and the finish flooring, is included by most estimators under the heading Concrete Arches. Sometimes it is put under Cement Finish Work, instead. Roof

fill (crickets), to give slope to the top surface for drainage of rain water, is handled with the floor fill. This fill material usually consists of a lean mixture of cinder concrete. In the case of sleeper fill for wood-floor finish, however, dry cinders are used.

A quick and fairly common method of estimating floor and roof arches is to compute the number of square feet of each and then apply a price per square foot. The cost per square foot is built up to suit the thickness

of the slab shown on the plans and the kind of wire reinforcement. It includes the temporary forms, the wire mesh, the cinder concrete, and all incidental expense. When this method of estimating is used, everything that affects the cost, such as the amount of work involved, the possible re-use of the forms, the economy of plant layout, and hoisting expense, is considered in building up the unit cost price.

The concrete portions of the beams and girders projecting below the slabs are listed separately. These are totaled in linear feet of beam and girder. The price is built up to suit the cross-section size of concrete. It is sufficient to provide for only a few different sizes for the encasing of steel beams and girders, as the cost per linear foot

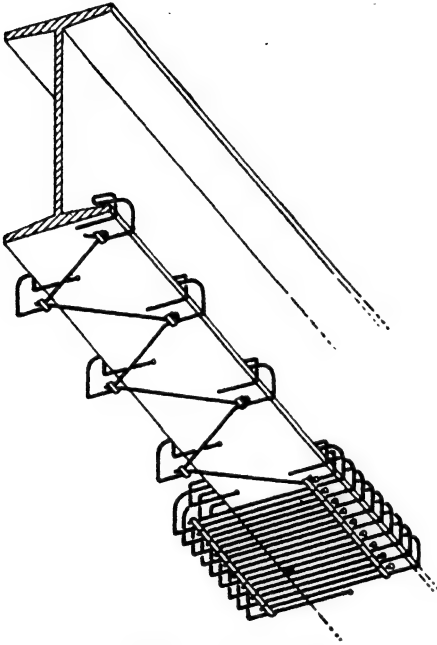


FIG. 36.—Soffit clips.

for the forms and the steel soffit clips will be practically the same for several sizes that are of approximately the same cross-section dimensions.

Concrete floor and roof slabs, complete with all formwork, reinforcing mesh, and cinder concrete, cost the contractor between 50¢ and 75¢ per square foot, depending upon the amount of work involved and the composition of the thickness of the slabs. Beam and girder covering costs between 70¢ and \$1.00 per linear foot. Specially large girders require special analysis and pricing to suit the size.

Each portion of the building and each kind of work should be listed separately, in order that the proper unit prices may be applied. Floor and roof fill is best measured in cubic yards, although some estimators continue to use square feet, as in the listing of the floor slabs. A good method is to show the total quantity both in cubic yards and in square feet and then to check the pricing both ways.

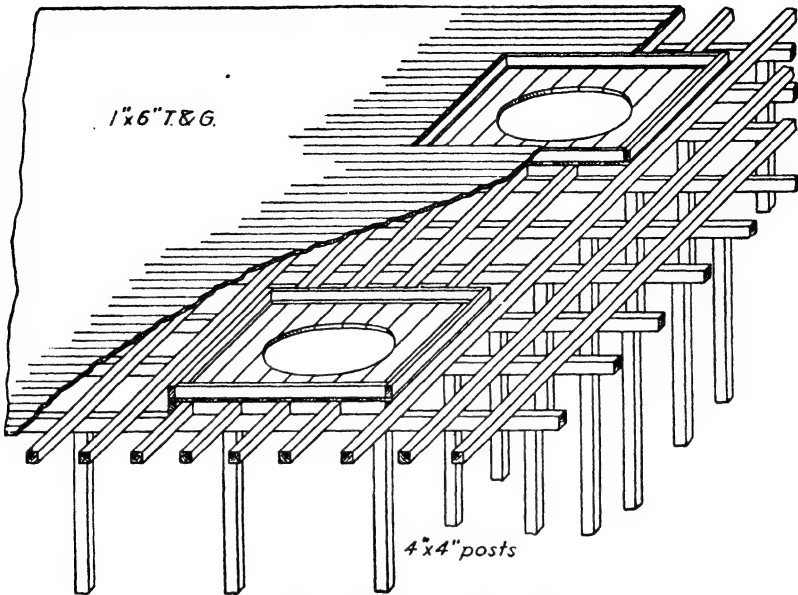


FIG. 37. Formwork for flat-slab construction.

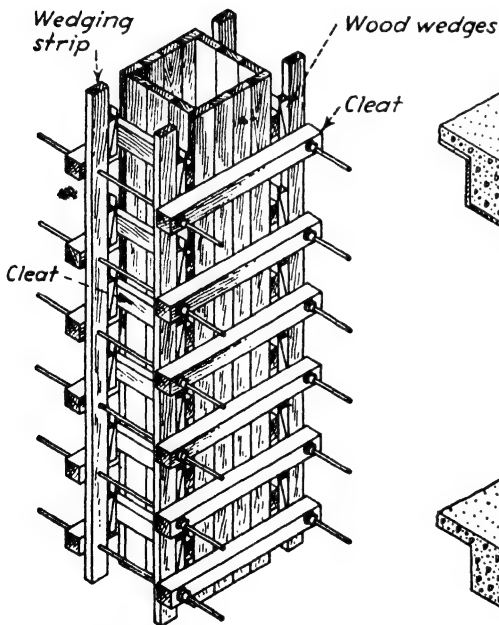


FIG. 38.

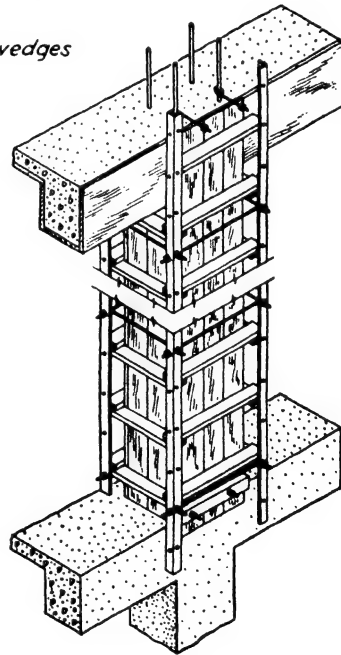


FIG. 39.

FIGS. 38 and 39. — Column forms and clamps.

Estimators should use all the plans for reference when estimating any one division and not depend upon only those drawings that are primarily concerned. The other drawings will often help toward a clearer understanding of the detail requirements. In the case of concrete floors and

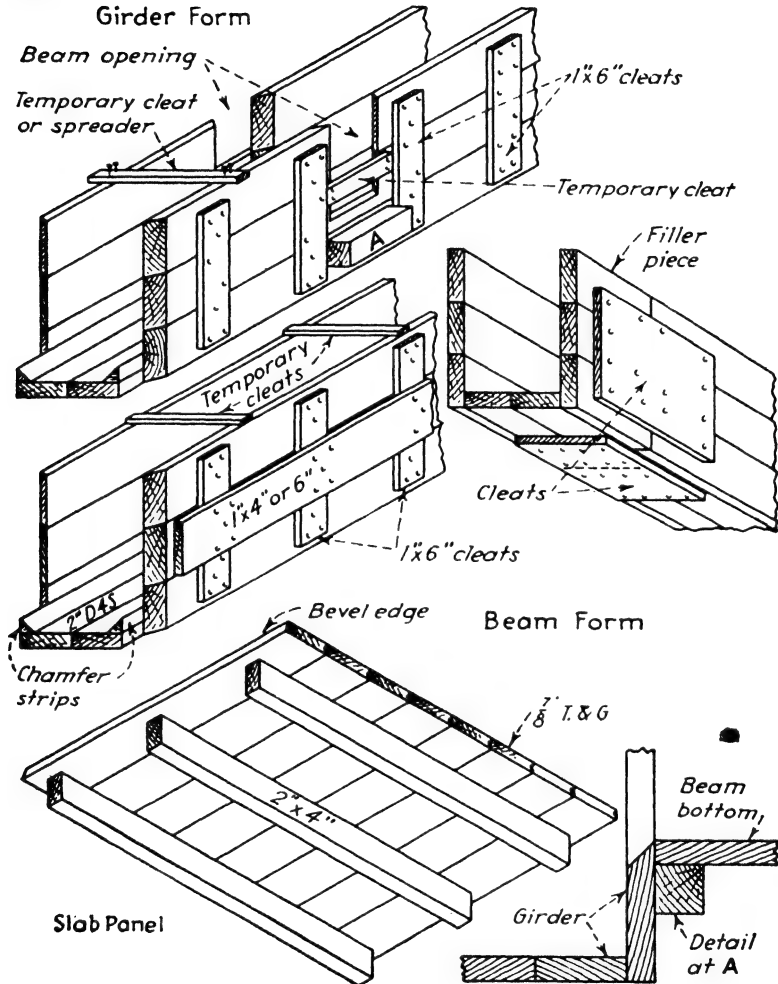


FIG. 40.—Girder and beam forms.

roofs with steel beams, the steel plans are referred to for the spacing of the beams and girders that are to support the construction. The steel itself is generally covered with concrete at the same time that the floor and roof construction is being installed.

Cinder-concrete slabs are usually of 1:2:5 mix, and this is used for the covering of the steel, as well. The reinforcing mesh is made of cold-drawn steel wire, in rectangular- or triangular-shaped mesh. The forms are

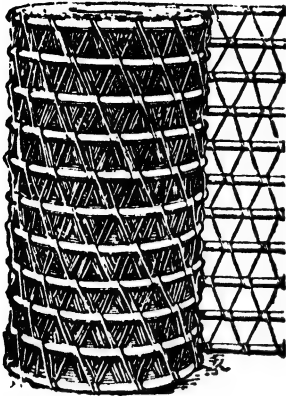


FIG. 41.—Triangular-woven mesh.

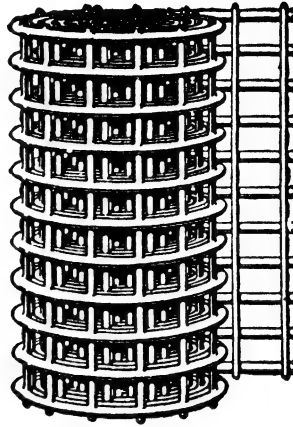


FIG. 42.—Rectangular-welded mesh.

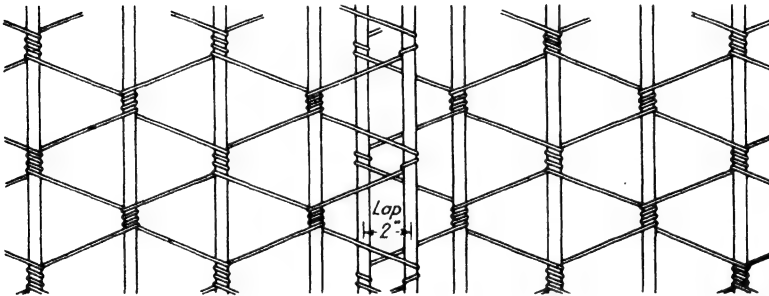


FIG. 43.—Triangular mesh with 2" side lap.

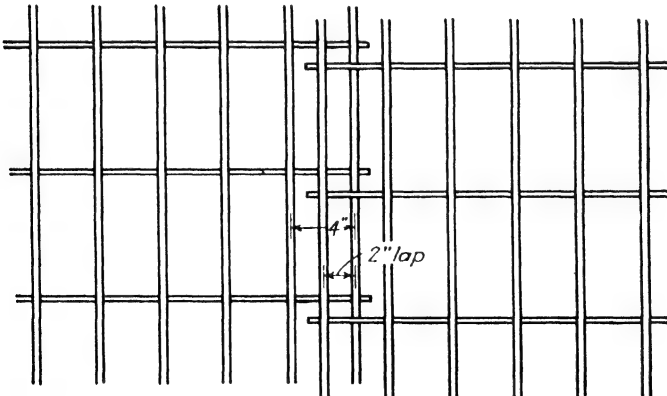


FIG. 44.—Rectangular mesh with 2" side lap.

supported by heavy wire hangers from the steel beams and girders. Forms for this work should not be removed for a week after the concrete is poured.

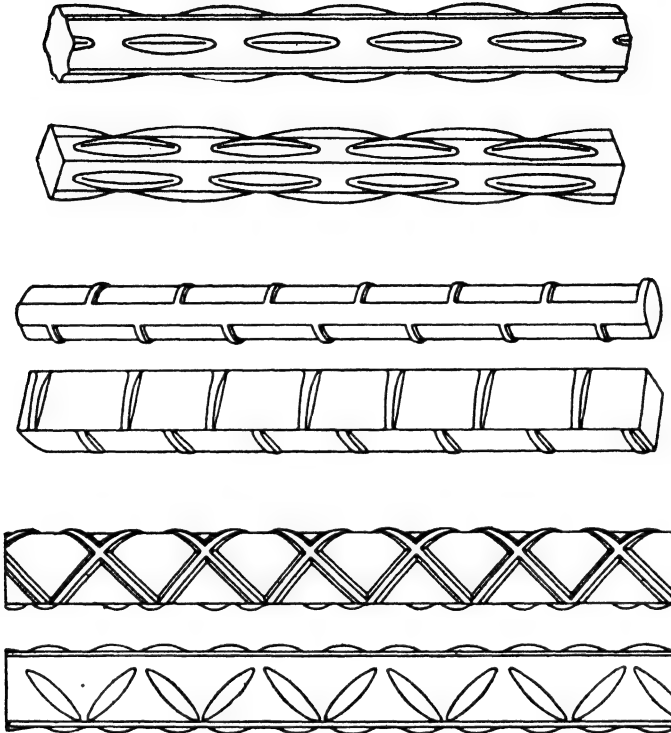


FIG. 45.—Types of reinforcing rods.

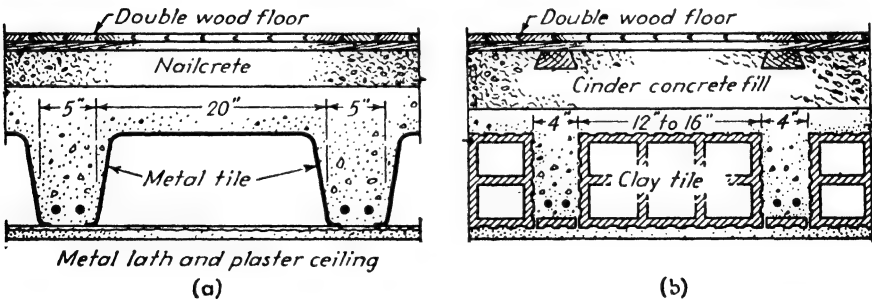


FIG. 46.—Pan- and block-floor systems.

In other slab construction of concrete, such as the flat-slab, beam-and-girder, metal-pan, and hollow-block systems, the aim is to find the quantity of concrete in cubic yards, by taking the gross area and thickness of the floor or roof, and deducting the openings, and—in the pan and block

systems—the volume of the blocks or of the voids formed by the pans. The number of linear feet of pans or blocks is separately listed.

The total area of the floor or roof is taken for the supporting form-work. The steel rods are computed by listing the number and length of the bars of each size, and from this determining the total weight of steel. The top finish, if it is of cement, is expressed in square feet and is entered under the heading, Cement Finish Work.

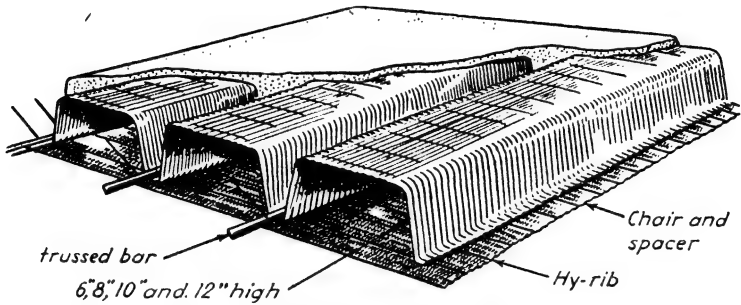


FIG. 47.—One-way system.

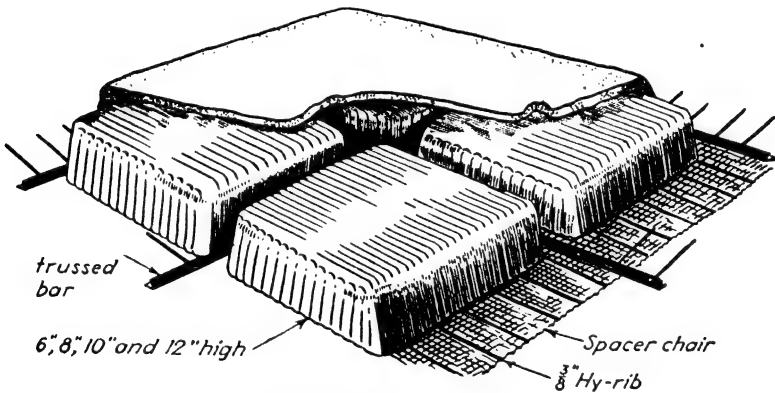


FIG. 48.—Two-way system.

**Hoisting expense** must always be considered. The method of hoisting is studied and proper figures are entered, either under the division of work requiring hoisting or in the job expense sheet. If it is not listed on the sheets concerned with the divisions of work, the hoisting item should at least be noted on them in order to form a check toward making sure that this item is properly entered on the general expense sheet.

**Concrete-joist** construction is becoming more popular for floors and roofs. This consists of concrete girders and beams, with concrete joists between the beams, reinforced with steel rods. Note the use of the term "joist" here. It is needed when three members—girders, beams, and

joists—make up the construction. The joists are spaced quite close together and the spaces between them formed by metal pans or block fillers, as has been noted above.

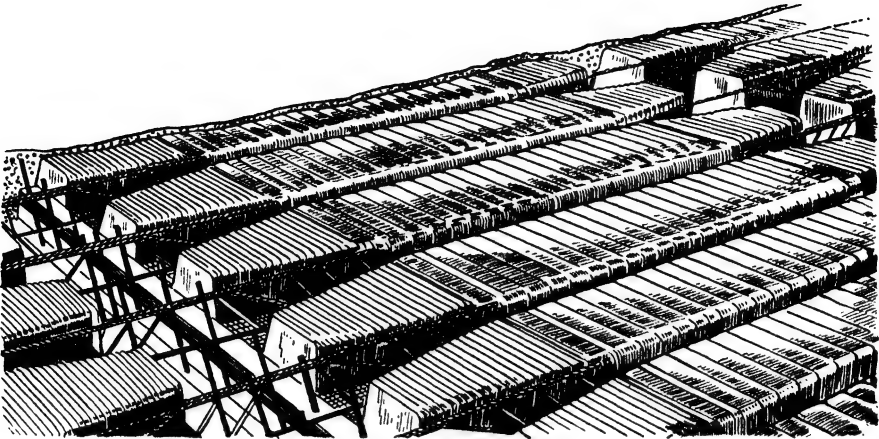
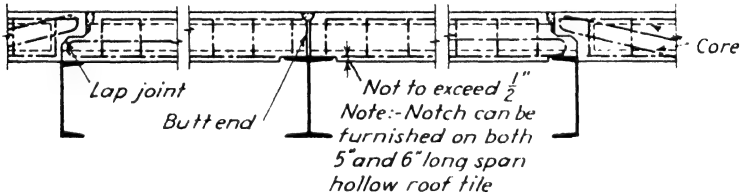
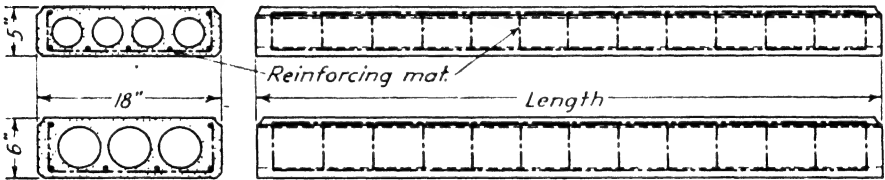


FIG. 49.—Cantilever pan system.



| Length          | 4'-0" to 6'-6" | 4'-0" to 6'-6" |
|-----------------|----------------|----------------|
| Depth           | 5"             | 6"             |
| Wt. per Sq. Ft. | 20 lbs.        | 25 lbs.        |

FIG. 50. —Long-span roof slab.

**Pans** of lightweight metal are used when they are to be left permanently in place, and heavier pans when they are to be removed and reused. If clay or gypsum blocks are used, these are left in place. Each system has its own merits; and the architect, having selected the one best adapted to the requirements of the particular job, specifies or shows the system desired. If no ceiling is required on the floor below, the pan system is sometimes favored rather than the block system. The only

form supports required for either of these systems are those under the girders, beams, and joists, as the pans or tile blocks form the sides of the girders, beams, and joists. For girders that are deeper than the joists, however, side forms are required for those portions that extend below. These side forms must be separately measured and totaled in square feet. Blocks and pans are both obtainable with closed ends for use against the beams and girders and for the two-way system in which the joists run crisscross instead of parallel to one another.

**Gypsum-tile blocks** made for fillers are 19"  $\times$  18" and are 6", 8", 10", or 12" in depth. The concrete ribs or joists between the blocks are usually made 4" or 5" wide. The top slab is 2" to 2½" thick.

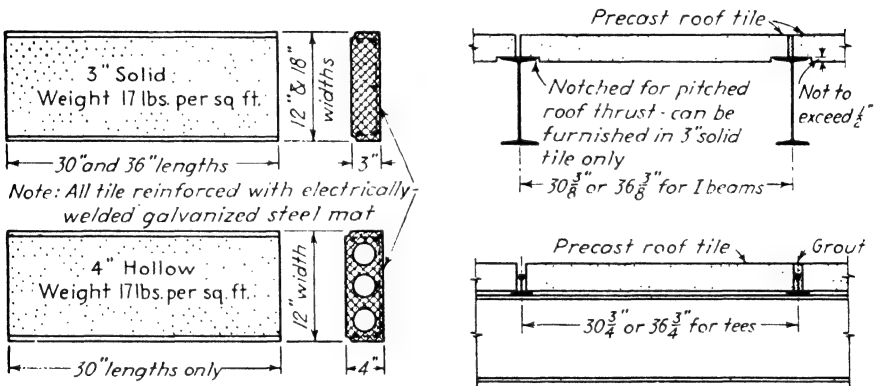


FIG. 51. - Short-span roof tile.

**Metal pans** of the removable type are No. 14 or No. 16 gauge, and those intended to be left in place are No. 26 gauge. The metal pans are laid end to end and lapped one corrugation. They are 20' wide and from 30" to 48" long, for the one-way system.

**Precast floor and roof slabs** are also made, some of the types being patented. These run from 2" to 6" in thickness and are reinforced with wire mesh or rods. One type in fairly common use is 2½" thick, 24" wide, and 30" long, and is designed for use in floors. Roof slabs are made 12", 18", and 24" wide and in lengths of up to 7'0".

**The flat-slab system** of concrete construction consists of columns with flared caps and with thick portions of slabs over the caps, called "drops." The balance of the floor or roof is a slab of uniform thickness. The reinforcing rods are run across the tops of the columns over the entire slab area, running either two ways or four ways. In the two-way system the rods run across the columns both ways and also diagonally across the columns.

Figures 52 to 63 show additional details pertaining to concrete construction.

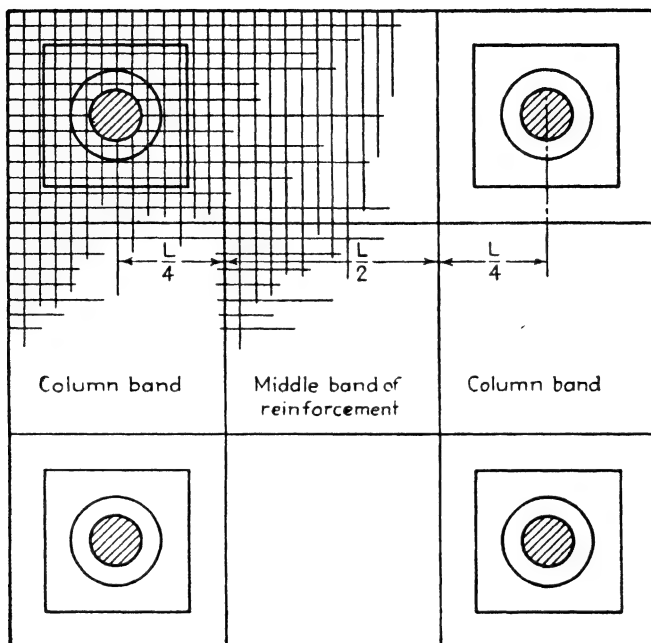


FIG. 52.—Two-way system.

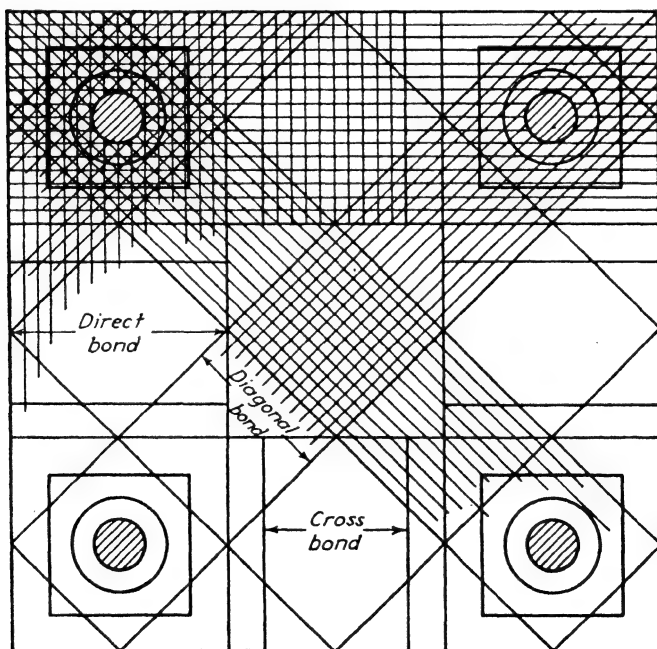


FIG. 53.—Four-way system.

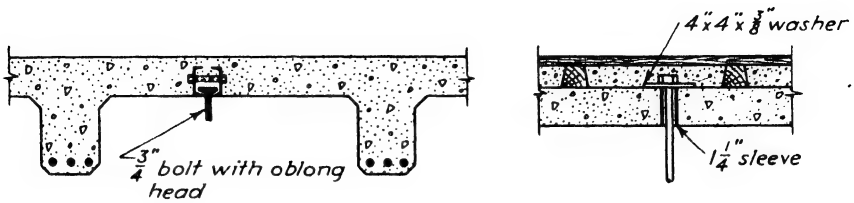


FIG. 54.—Hanger inserts.

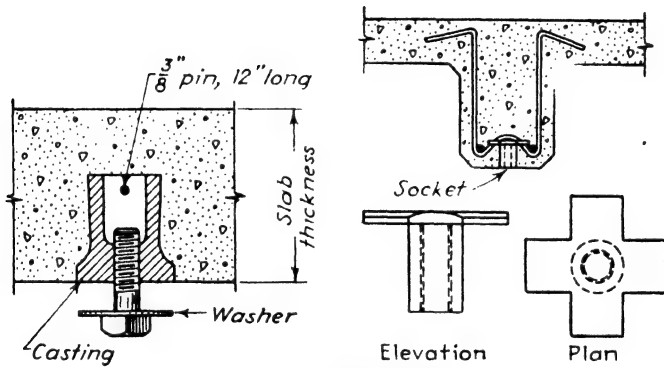


FIG. 55.—Hanger inserts.

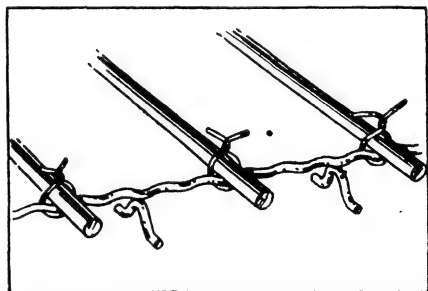
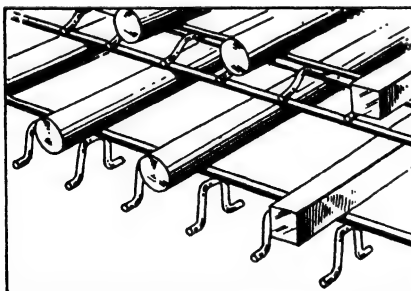
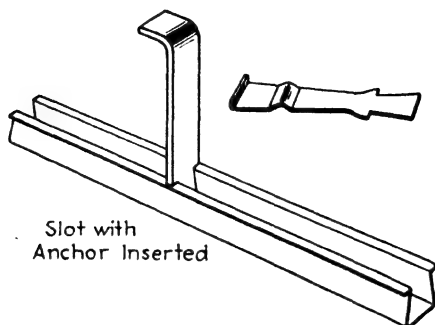
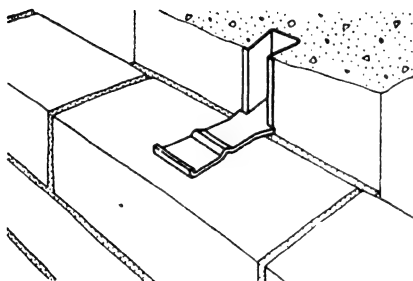


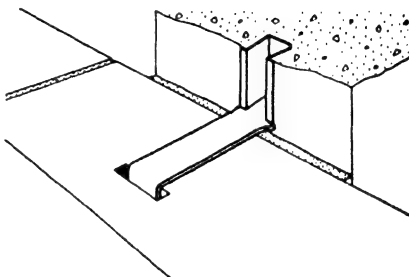
FIG. 56.—Bar bolsters.



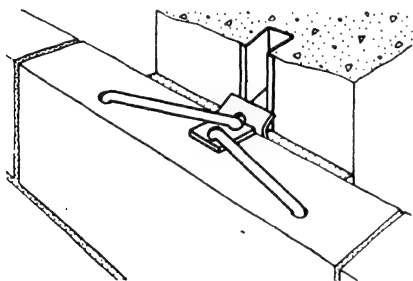
Slot with  
Anchor Inserted



Anchoring Brick to Concrete  
The anchor can be inserted at any  
height desired

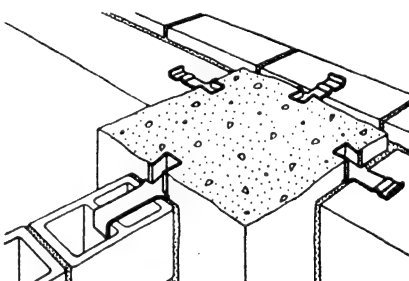


Anchoring Stone to Concrete  
A twist of the wrist puts the anchor  
in the slot at any course height



Anchoring Terra Cotta and Tile  
to Concrete

Two rods placed in the holes in the anchor which may be inserted at any height hold the terra cotta or tile tightly to the concrete



On Columns With Brick Facing

Anchors in columns with brick facing and tile partition

FIG. 57.—Masonry anchors and slots.

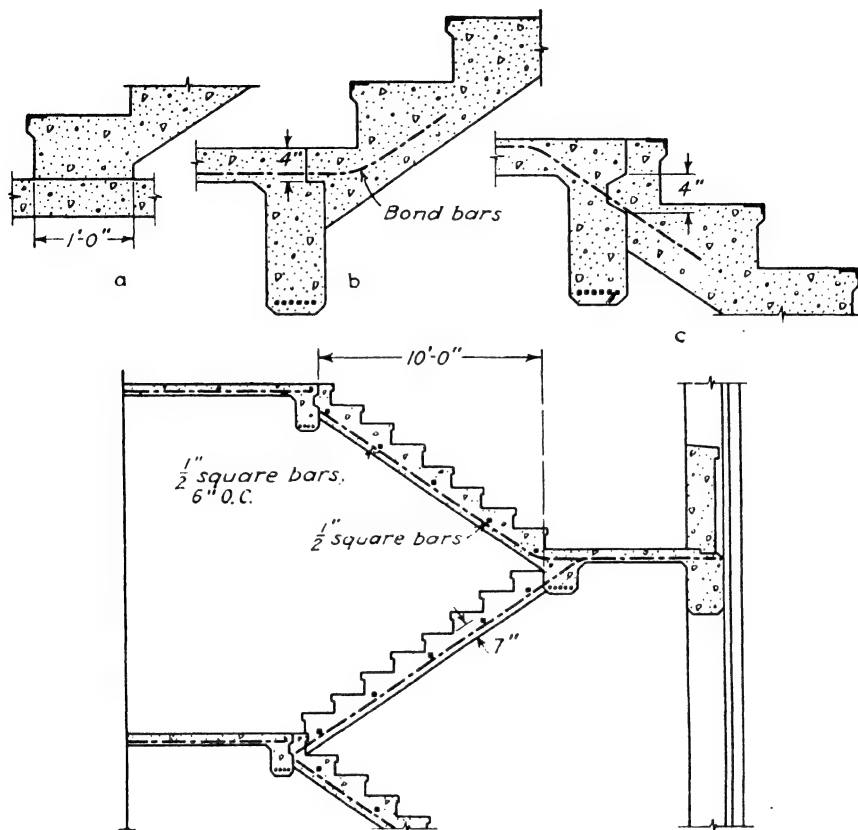


FIG. 58. Concrete stairs.

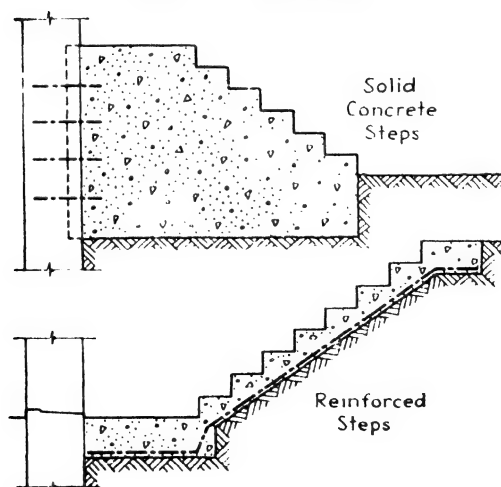


FIG. 59. Concrete steps.



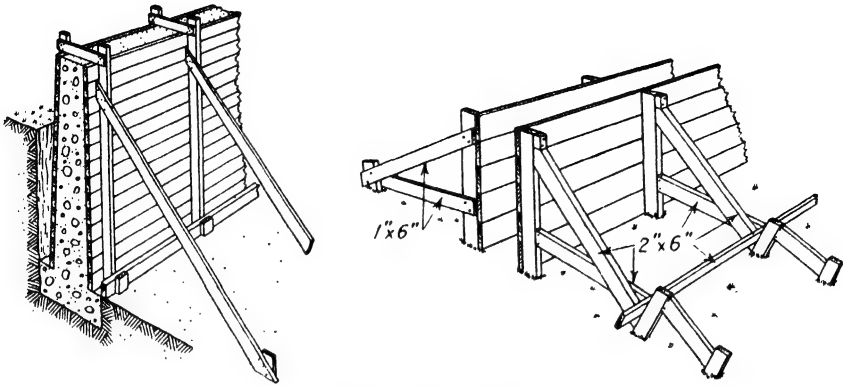


FIG. 63.—Wall forms.

### Exercises

1. Make sketches showing three different types of floor construction, with arches and finish.
2. Make sketches showing three different types of floors and pavements on earth.
3. Write at least 300 words of notes on concrete floors and roofs, taken from one or two of the books listed in the Preface. Name the books used.
4. State the meaning and use of the following terms, giving sketches where possible: steel-beam fireproofing, floor fill, roof cricket, soffit clips, flat-slab system, beam-and-girder system, anchor slot.
5. Make a complete estimate of the concrete floors and roof shown on the plans in Chap. XXV.

## CHAPTER XIII

### MASONWORK

The masonry division of the estimate includes all the work done by bricklayers and bricklayers' helpers. The heading for this division is Masonwork, Masonry, or Brickwork. A more clearly descriptive term, although it is one that is never employed, would be Bricklayers' Work.

Materials that are used in masonwork include common brick, face brick, firebrick, terra cotta blocks, gypsum blocks, terra cotta flue lining, and terra cotta coping. Incidental materials are sand, cement, lime, wall ties, and muriatic acid (for cleaning). The equipment needed includes mortar boxes, hoes, shovels, wheelbarrows, mortarboards, scaffolding, mortar mixers, etc.

The street-front walls and the returns from these walls for a specified distance are generally faced with one thickness, 4", of face brick. Sometimes other portions of walls also are faced with face brick. Common brick is used for the backing up of the walls that have face brick, for rear-wall construction, and for brick chimneys and partitions.

**Terra cotta blocks**, as considered under the masonry heading, commonly refer to the structural blocks and not to the type that have specially treated surfaces. The latter are referred to as architectural terra cotta and often are put under a special heading. Structural terra cotta blocks of the regular kinds are made in thicknesses of 2", 3", 4", 6", 8", and 10". They are all 12"  $\times$  12" in face size. These blocks, especially the 3", 4", and 6" sizes, are used mainly to build partitions, and the 2" and 3" sizes are used for column covering and wall furring. Terra cotta blocks are also used to form exterior walls and for backing up in exterior walls—although specially shaped blocks are now in more common use for backing-up purposes.

**Gypsum blocks**, sometimes referred to as "plaster blocks," are made in thicknesses of 2", 3", 4", 5", and 6". The 3" and 4" thicknesses are by far the most common. They are all 12"  $\times$  30" in size; therefore, one block equals 2½ square feet, whereas a regular terra cotta block is 1 square foot. Gypsum blocks are used almost exclusively to form partitions. Being made of a porous plaster composition, they are much lighter in weight and of less strength than the terra cotta blocks.

Terra cotta flue lining is clay pipe and is usually made in lengths of two feet. It is used to line the inside of chimneys and can be had in

round, square, and rectangular shapes. Stock sizes run from 6" to 24" in cross section. Terra cotta coping, sometimes called "tile" coping or

| MASON WORK               |  |  |  |  |               |  |  |  |  |
|--------------------------|--|--|--|--|---------------|--|--|--|--|
| COMMON BRICK             |  |  |  |  |               |  |  |  |  |
| BASEMENT                 |  |  |  |  |               |  |  |  |  |
| Boiler Room              |  |  |  |  |               |  |  |  |  |
| 69'-0" x 11'-10" x 1'-0" |  |  |  |  | 817           |  |  |  |  |
| OUTS                     |  |  |  |  |               |  |  |  |  |
| 3-4 x 7-6 x 1-0 25       |  |  |  |  |               |  |  |  |  |
| 5-0 x 7-4 x 1-0 36       |  |  |  |  | - 61          |  |  |  |  |
|                          |  |  |  |  | 756           |  |  |  |  |
|                          |  |  |  |  | x 20          |  |  |  |  |
|                          |  |  |  |  | 15120 brk 40- |  |  |  |  |
|                          |  |  |  |  | 605           |  |  |  |  |
| FIRST FLOOR              |  |  |  |  |               |  |  |  |  |
| North Wall               |  |  |  |  |               |  |  |  |  |
| 102-8 x 17-3 x 0-4       |  |  |  |  | 590           |  |  |  |  |
|                          |  |  |  |  | x 20          |  |  |  |  |
|                          |  |  |  |  | 11800 brk 43- |  |  |  |  |
|                          |  |  |  |  | 507           |  |  |  |  |
| North parapet            |  |  |  |  |               |  |  |  |  |
| 20-0 x 3-6 x 1-0         |  |  |  |  | 70            |  |  |  |  |
| East Wall                |  |  |  |  |               |  |  |  |  |
| 83-2 x 20-9 x 1-0        |  |  |  |  | 1726          |  |  |  |  |
|                          |  |  |  |  | 1796          |  |  |  |  |
|                          |  |  |  |  | x 20          |  |  |  |  |
|                          |  |  |  |  | 35920 brk 41- |  |  |  |  |
|                          |  |  |  |  | 1473          |  |  |  |  |
| Garage front & rear      |  |  |  |  |               |  |  |  |  |
| 20-0 x 20-6 x 0-8        |  |  |  |  | 273           |  |  |  |  |
| 19-0 x 17-0 x 1-0        |  |  |  |  | 323           |  |  |  |  |
| OUTS                     |  |  |  |  | 596           |  |  |  |  |
| 12-0 x 12-2 x 0-8 97     |  |  |  |  |               |  |  |  |  |
| 6-9 x 8-6 x 1-0 57       |  |  |  |  | - 154         |  |  |  |  |
|                          |  |  |  |  | 442           |  |  |  |  |
|                          |  |  |  |  | x 20          |  |  |  |  |
|                          |  |  |  |  | 8840 brk 42-  |  |  |  |  |
|                          |  |  |  |  | FYD. 2956     |  |  |  |  |

FIG. 64.—Masonwork estimate.

"crock" or "saddleback" coping, also comes in two-foot lengths. It is used to cap 8" 12", and 16" walls.

The handling and setting of stone window sills and lintels in brick walls comes under the masonry heading, as do, also, the handling and setting of isolated pieces of stone trimmings and small iron fittings, angle-iron lintels, etc.

**Brickwork** is measured per thousand bricks. This is obtained by first computing the number of cubic feet of solid brickwork. All brickwork, whether common brick, face brick, or firebrick, is best handled by consistently finding the number of cubic feet of actual solid brickwork. All the

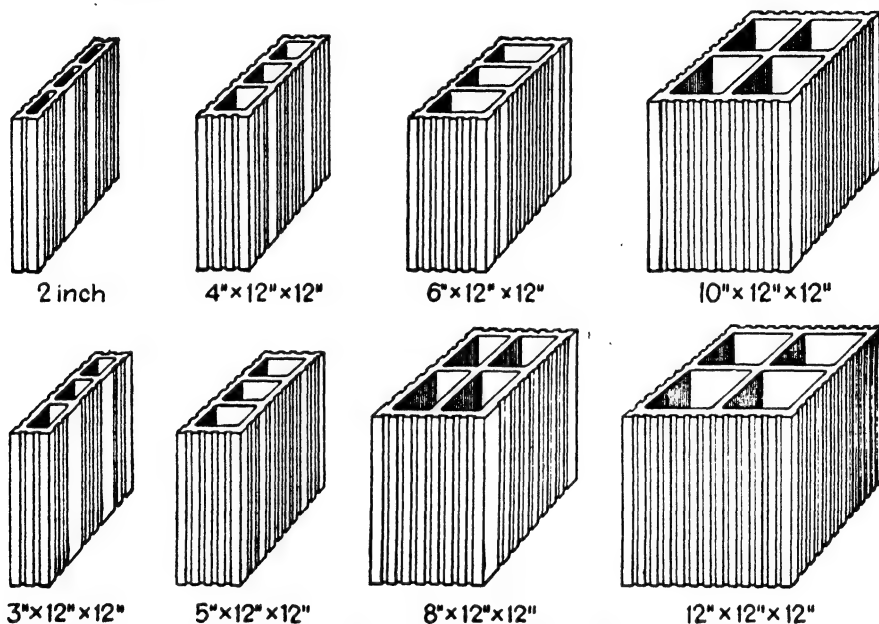
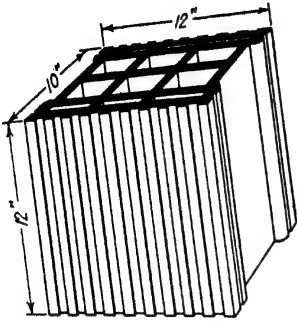


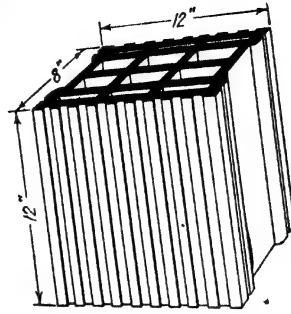
FIG. 65.—Terra cotta blocks for partitions.

brickwork of each kind is measured separately in cubic feet. This volume is multiplied by 20 in order to get the number of bricks involved. For all practical purposes, an allowance of 20 bricks per cubic foot is accurate enough, although the number will vary slightly according to the size of brick used and the thickness of the mortar joints. The number of bricks is separately extended for each item or group of similar items. This is priced at the cost per thousand bricks, laid in place complete, with all expense of material, labor, and incidentals considered in the unit cost. With this uniform measurement, it does not matter how thick a wall is to be or even whether the brickwork is to be in a wall or not; the same treatment may be consistently applied. Often brickwork is filled in around steel, as in spandrels and in piers; or is built up in odd shapes and thicknesses, as at chimneys and tank or machine foundations. Walks and drives and fire linings may be only 2" or 4" thick. The thick-

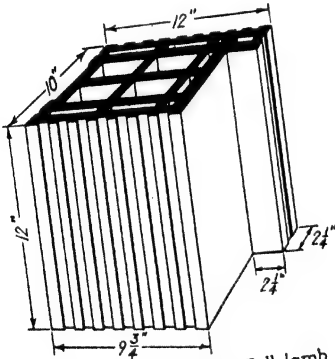
## MASONWORK



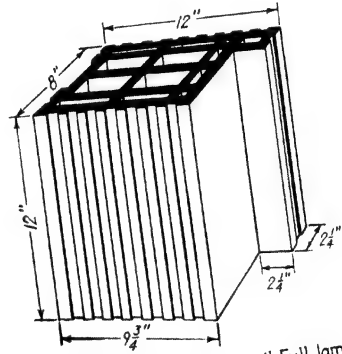
10" x 12" x 12" Double Shell  
Wall Tile



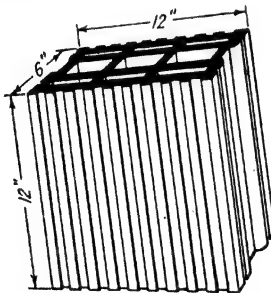
8" x 12" x 12" Double Shell  
Wall Tile



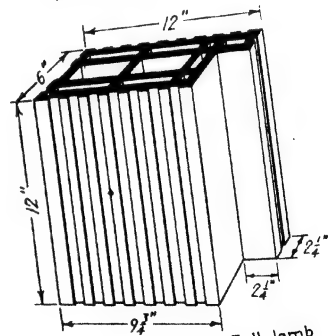
10" x 12" x 12" Double Shell Full Jamb  
for Box Frame Windows



8" x 12" x 12" Double Shell Full Jamb  
For Box Frame Windows



6" x 12" x 12" Double Shell  
Wall Tile



6" x 6" x 12" Double Shell Full Jamb  
For Box Frame Windows

FIG. 66.—Load-bearing terra cotta.

ness of solid brick walls and partitions is regularly a multiple of 4"—the nominal thickness of a brick as laid. Thus, walls or partitions are usually 4", 8", 12", 16", etc., in thickness.

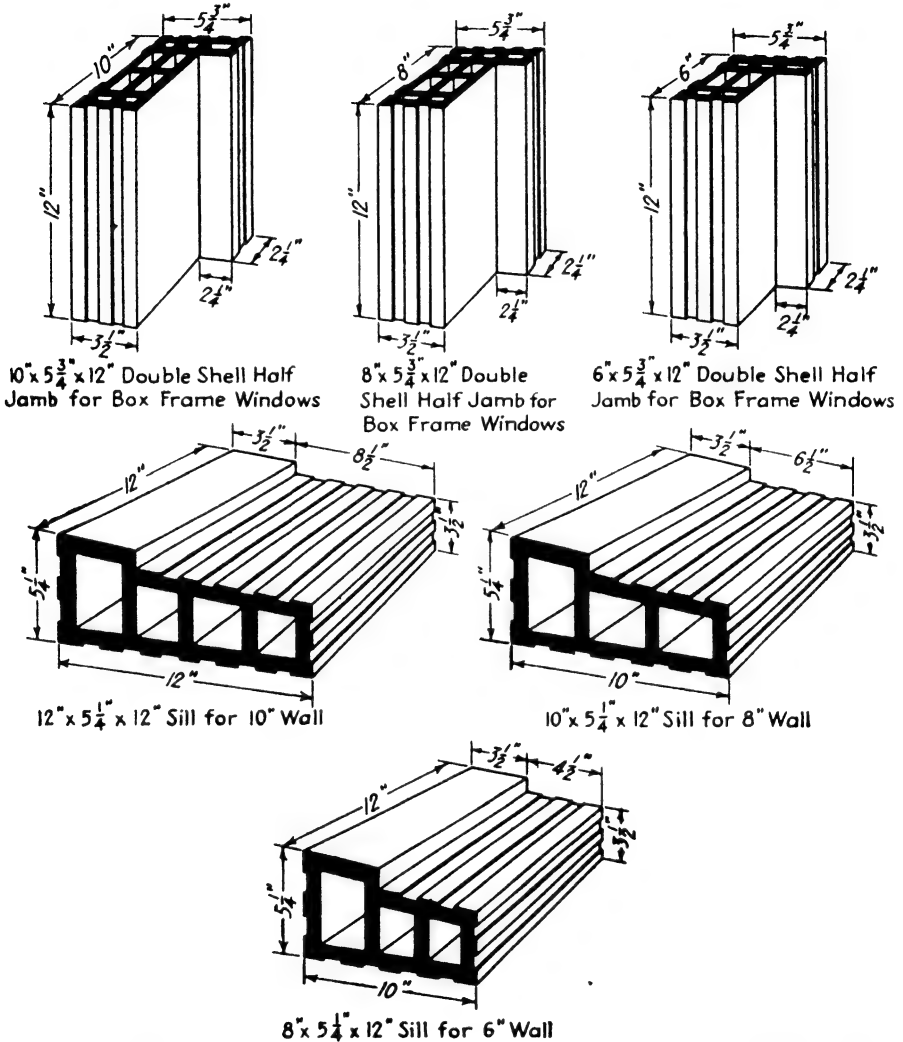


FIG. 67.—Special shapes for load bearing.

Of course, the entries for the estimate are from measurements taken accurately from the plans, and they are grouped in orderly fashion under appropriate minor headings. Even though many of these minor headings may refer to one kind of brick, the total is extended separately for each group, so that it may be given a separate unit price. This is necessary because, in the analysis of the cost, there may very well be different

labor amounts or other considerations besides the cost of the material that will make the unit cost of one group greater than that of another group where the same material is concerned.

The method of measuring and entering the items for masonwork is illustrated by sample entries of several portions in Fig. 64. Note that the net amount of work is extended; that is, the gross volume of the

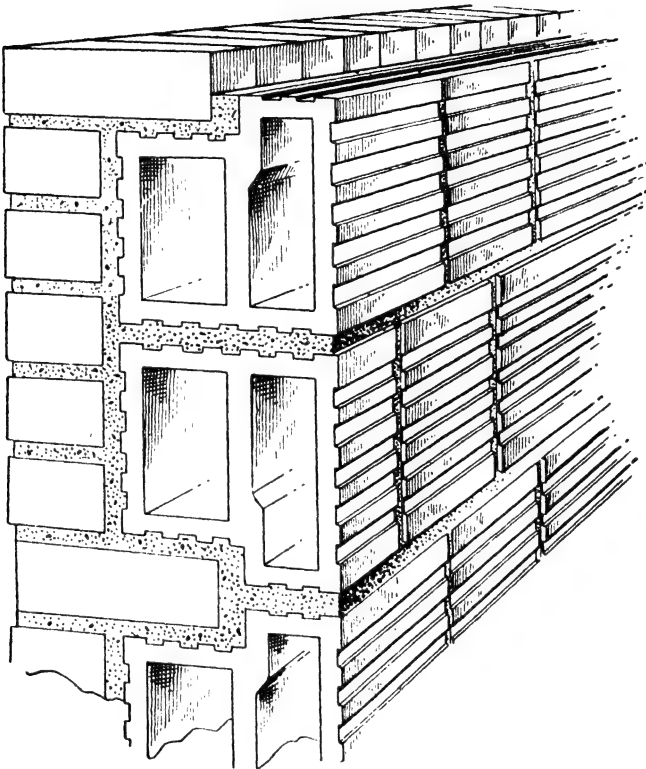


FIG. 68. Back-up blocks.

brickwork or the gross area of the terra cotta or gypsum partitions is first entered. Then the openings are deducted by entries that are technically called "outs." These deductions are made before the final extensions are arrived at.

Terra cotta and gypsum-block work of partitions, column covering, furring, etc. are measured and priced by the square foot, complete in place. Flue lining and coping are handled by the linear foot. The setting of stones and iron fittings is priced per piece.

All this estimating is subdivided into small parts and arranged neatly so that it may be properly priced and checked. Skip lines after each

group, in order that adjustments can be made readily and also that the estimate may be read more easily.

**Masonry Costs.** Common brickwork costs the contractor between \$33 and \$43 per thousand complete, in place, not including insurance. The bricklayers lay between 1,000 and 1,500 bricks in a day. Face brickwork costs the contractor between \$70 and \$100 per thousand complete, in place. Bricklayers can lay only about 600 of these in a day. The amount of work produced in any given time will depend on the type and thickness of the wall and on conditions of working and other factors. From one-half to two-thirds of a cubic yard of mortar is required for each

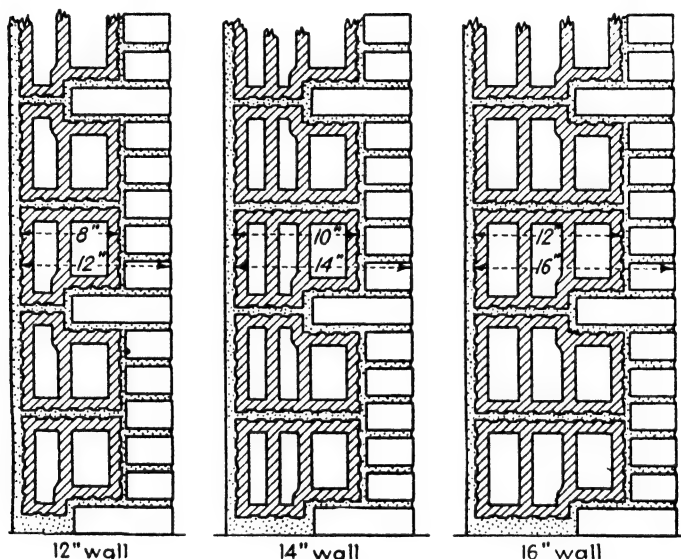


FIG. 69.—Combination walls.

thousand brick. Terra cotta partitions cost the contractor 15¢ to 30¢ per square foot; and gypsum-block partitions, 14¢ to 25¢ per square foot, in place complete, for regular work. Terra cotta coping runs 40¢ to 60¢, and flue lining 50¢ to \$2.50 per linear foot. A range for handling and setting isolated pieces of stone and iron would be 50¢ to \$2.00 per single piece. All these prices are rough approximations, simply to furnish an illustration of the relation between them and to give the student some feeling for the cost of the work. Prices of labor and material and incidental items change from time to time, and each job has its own peculiarities that will affect the unit costs.

Add 1¢ to 2¢ per square foot for the mortar required for TC or gypsum blocks of 4" or less thickness. Add 2¢ to 4¢ per square foot for thicker blocks and for concrete blocks. The amount will vary according to the thickness of the blocks, the face size of the blocks, the type of block used,

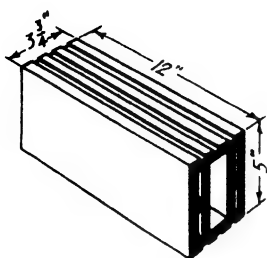
and the thickness of the joints. For all ordinary jobs the allowance can be approximated quite closely; for large jobs it should be analyzed and priced more accurately.

The allowance of 20 bricks per cubic foot already provides about 5% for waste; therefore, no further allowance is necessary. However, as has been stated before, on very large jobs the size of the actual bricks that are to be used, as well as the thickness of the joints, should be known, and then a study should be made of the actual number to be allowed per cubic foot. If such a study is considered necessary, a study of the mortar requirements also should be made. In fact, all the requirements for a large job should be analyzed more extensively than those for a small job. A large job is one involving more than 500,000 brick. If a large number of face brick—say, 50,000 or more—are required, these should be analyzed as to the number of full headers required, and an entry should be made for the adjustment of the figures.

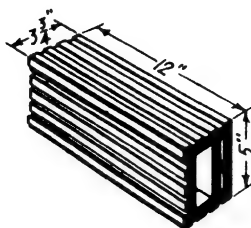
The number of bricks to be added for headers is, of course, for only the number of full headers. The pattern of the brick appearing on the face of the wall may be in any bond, but most of the headers may be only half bricks, especially if the face brick are expensive, and therefore both halves would be used and no additional bricks required for such headers. If Flemish bond is formed, for example, with full headers used only every sixth course, the additional brick for these headers would amount to only one-eighteenth of the total number of face brick. To make the adjustment for this additional cost it is necessary to take the difference between the cost of the common brickwork and the cost of the face brickwork and multiply it by one-eighteenth of the number of face brick. Thus, if 10,000 face brick were counted for the job without considering headers, and the cost of the common and face brickwork were \$45 and \$70 per M, respectively, the adjustment would be an addition of one-eighteenth of \$250, the difference in cost for 10,000 bricks at the prices noted. The answer would be \$14, an amount so small that an experienced estimator could approximate it without any figuring.

If any of the usual joints are to be used for the faces of brickwork, the labor cost of laying the brick will be about the same for one as for another. Sometimes, however, joints out of the ordinary are called for, such as raked-out, concave, convex, or rodded joints, for each of which an additional  $1\frac{1}{2}$  to 2 hours of labor for each thousand bricks are required. For stripped joints, in which a wood strip is left in the joint for a short time, to form a true rectangular recess, a whole day's time of a bricklayer, per M bricks, must be added.

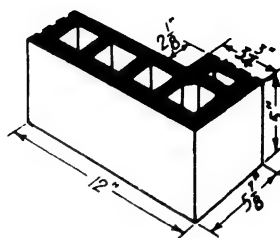
A bricklayer will clean down about 800 square feet of wall per day, if the bricks are fairly smooth and not much repointing of the joints is necessary. The cost of this work, including the acid, pails, and brushes,



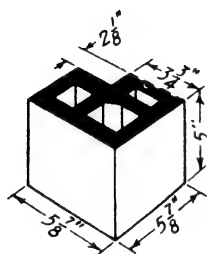
$3\frac{3}{4} \times 5 \times 12$ " Wall Stretcher  
(smooth two sides)  
also furnished in 2", 3", 4",  
 $5\frac{7}{8}$ ", 8" and 10" lengths



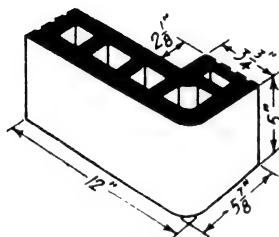
$3\frac{3}{4} \times 5 \times 12$ " Wall Stretcher  
(smooth one side,  
scored one side),  
also furnished in 2",  
3", 4",  $5\frac{7}{8}$ ", 8" and 10"  
lengths



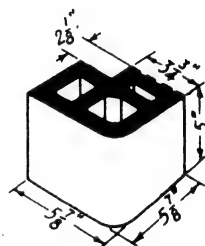
$3\frac{3}{4} \times 12 \times 5$ " Square  
External and Internal  
Corner



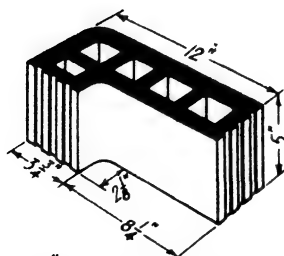
$3\frac{3}{4} \times 5\frac{7}{8} \times 5$ " Square  
External and Internal  
Half Corner



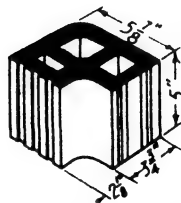
$3\frac{3}{4} \times 12 \times 5$ " Bullnose  
External and Square  
Internal Corner



$3\frac{3}{4} \times 5\frac{7}{8} \times 5$ " Bullnose  
External and Square  
Internal Half Corner

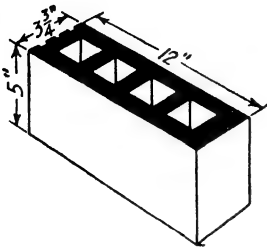


$3\frac{3}{4} \times 12 \times 5$ " Bullnose  
External and Coved  
Internal Corner

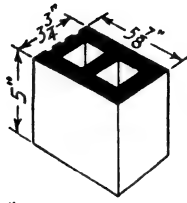


$3\frac{3}{4} \times 5\frac{7}{8} \times 5$ " Bullnose  
External and Coved  
Internal Half Corner

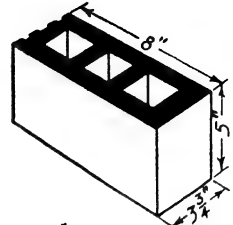
FIG. 70.—Surface terra



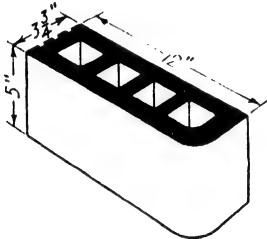
$3\frac{3}{4} \times 12 \times 5$  Square Full Closure



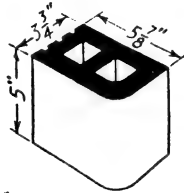
$3\frac{3}{4} \times 5\frac{7}{8} \times 5$  Square Half Closure



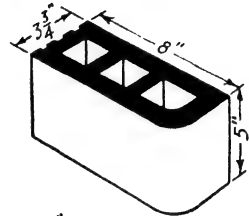
$3\frac{3}{4} \times 8 \times 5$  Square Pilaster



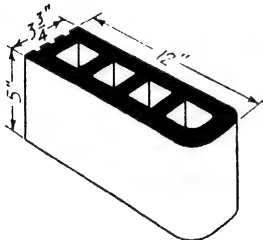
$3\frac{3}{4} \times 12 \times 5$  Single Bull-nose Full Closure



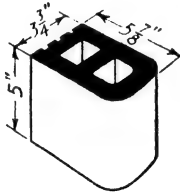
$3\frac{3}{4} \times 5\frac{7}{8} \times 5$  Single Bull-nose Half Closure



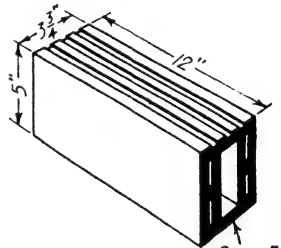
$3\frac{3}{4} \times 8 \times 5$  Single Bull-nose Pilaster



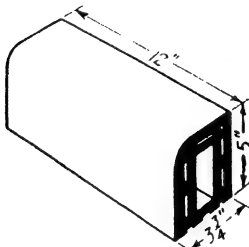
$3\frac{3}{4} \times 12 \times 5$  Double Bull-nose Full Closure



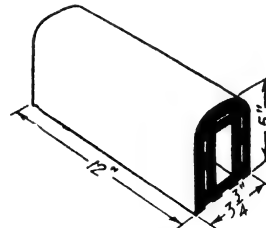
$3\frac{3}{4} \times 5\frac{7}{8} \times 5$  Double Bull-nose Half Closure



$3\frac{3}{4} \times 5 \times 12$  Square Sill or Lintel Tile. Also furnished in  $5\frac{7}{8}$  and 8" lengths

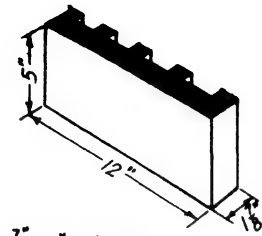


$3\frac{3}{4} \times 5 \times 12$  Single Bullnose Sill or Lintel Tile. Also furnished in  $5\frac{7}{8}$  and 8" lengths

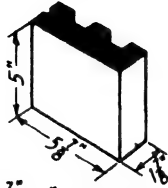


$3\frac{3}{4} \times 5 \times 12$  Double Bullnose Coping Tile. Also furnished in  $5\frac{7}{8}$  and 8" lengths

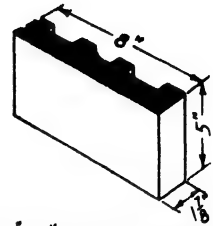
cotta blocks,  $3\frac{3}{4}$ " thick.



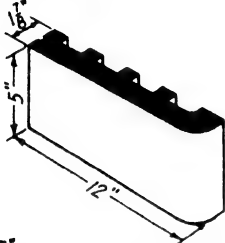
$1\frac{7}{8} \times 12 \times 5$  Furring, Square Full Closure



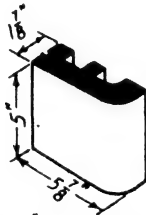
$1\frac{7}{8} \times 5\frac{7}{8} \times 5$  Furring, Square Half Closure



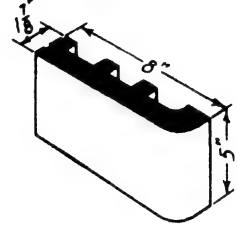
$1\frac{7}{8} \times 8 \times 5$  Furring, Square Pilaster



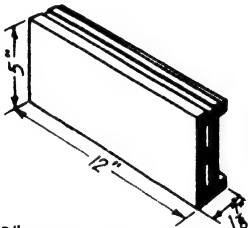
$1\frac{7}{8} \times 12 \times 5$  Furring, Bull-nose Full Closure



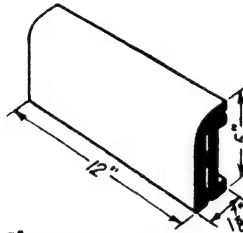
$1\frac{7}{8} \times 5\frac{7}{8} \times 5$  Furring Bull-nose Half Closure



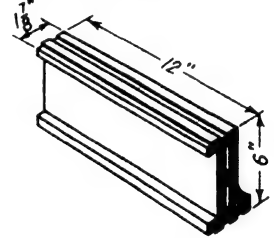
$1\frac{7}{8} \times 8 \times 5$  Furring, Bull-nose Pilaster



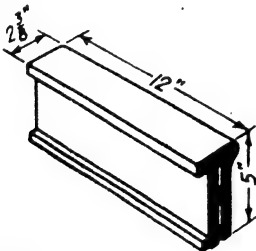
$1\frac{7}{8} \times 5 \times 12$  Furring, Square Sill or Lintel Tile. Also furnished in  $5\frac{7}{8}$  and 8" lengths (note one face and one edge finished)



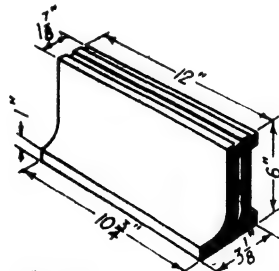
$1\frac{7}{8} \times 5 \times 12$  Furring, Bull-nose Sill or Lintel, Also furnished in  $5\frac{7}{8}$  and 8" lengths



$1\frac{7}{8} \times 6 \times 12$  Furring, Cove Base. Furnished in 2", 3", 4",  $5\frac{7}{8}$ , 8" and 10" lengths

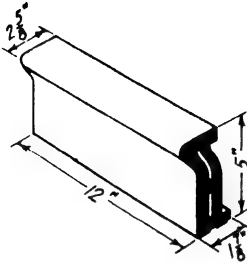


$1\frac{7}{8} \times 5 \times 12$  Furring Wainscot Cap. Furnished in 2", 3", 4",  $5\frac{7}{8}$ , 8" and 10" lengths

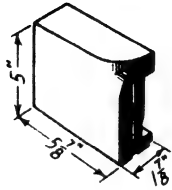


$1\frac{7}{8} \times 6 \times 12$  Furring, Cove Base, coped right (coped left opposite hand) Furnished in 3", 4",  $5\frac{7}{8}$  and 8" lengths

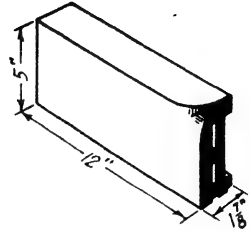
FIG. 71.—Surfaced terra



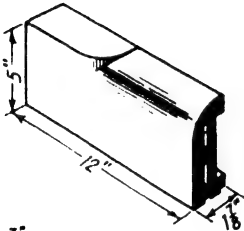
1 7/8" x 5" x 12" Furring, Wain-scot Cap, coped right. (coped left opposite hand) Furnished in 3", 4", 5 7/8" and 8" lengths



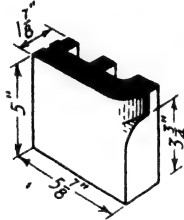
1 7/8" x 5" x 5 7/8" Furring, Bullnose Sill or Lintel Starter, left hand (right hand opposite)



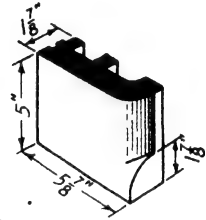
1 7/8" x 5" x 12" Furring, Bull-nose Sill or Lintel Starter, end type, left hand. (right hand opposite)



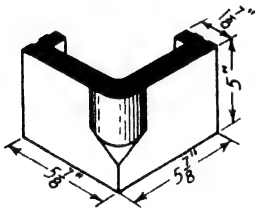
1 7/8" x 5" x 12" Furring, Bullnose Sill or Lintel Starter, center type, left hand. (right hand opposite)



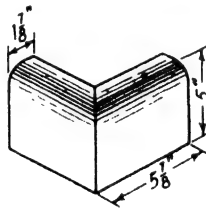
1 7/8" x 5" x 5 7/8" Furring, Bull-nose Sill Starter (for 1 7/8" Sill) left hand. (right hand opposite)



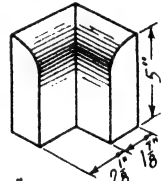
1 7/8" x 5" x 5 7/8" Furring, Bull-nose Sill Starter (for 3 3/4" sill) left hand. (right hand opposite)



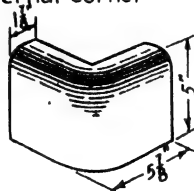
1 7/8" x 5 7/8" x 5" Furring, Chamfered Corner (external)



1 7/8" x 5 7/8" x 5" Furring, Bull-nose Coping, Square External Corner



1 7/8" x 2 1/8" x 5" Furring, Bull-nose Coping, Square Internal Corner



1 7/8" x 5 7/8" x 5" Furring, Bullnose Coping, Bullnose External Corner

runs about 3¢ to 5¢ per square foot. To this must be added any scaffolding that may be required and, of course, the insurance cost. In figuring cleaning areas, only very large openings are deducted.

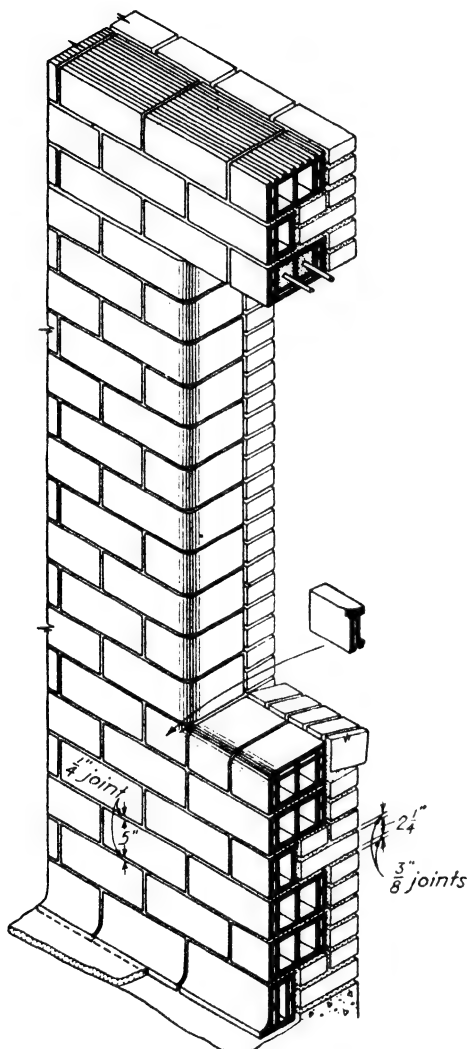


FIG. 72

Details of surfaced terra cotta work.

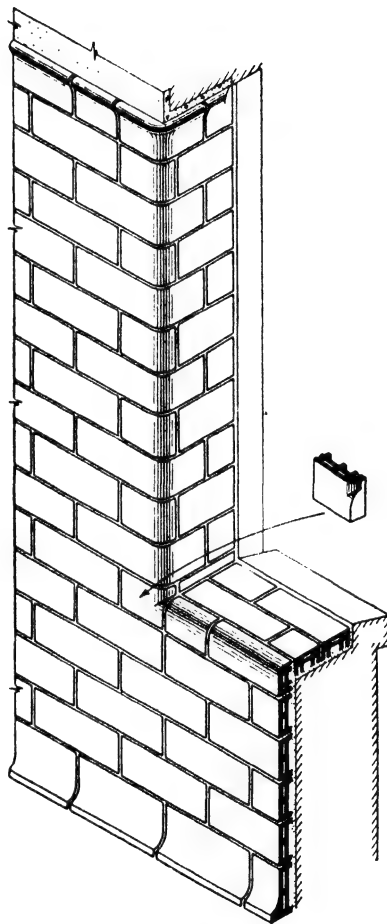


FIG. 73

The cost of scaffolding the exterior of ordinary buildings runs between 6¢ and 10¢ per square foot of wall, measuring the entire length and height of wall to be scaffolded. This will depend upon the amount of scaffolding, the type used, the amount of changing, etc.

A bricklayer will lay about 200 brick per day in fireplaces and about 400 per day in chimneys. He should set about 80 linear feet of TC flue

lining of the ordinary sizes. Thus, with the incidental laborer's time, the mortar, etc., fireplace brickwork should run between \$140 and \$170 per M; chimney common brickwork, \$60 to \$90, plus the cost of scaffolding; and ordinary flue lining 60¢ to \$1.00 per linear foot. Larger flue lining is so heavy that the cost per foot rises rapidly for both material and labor, 24" costing about \$5.00 per linear foot installed.

Fireplaces, chimneys, and other odd shapes can sometimes be best figured as though they were solid, and then the voids in them figured and subtracted from the gross volume, in order to arrive at the net volume of brickwork. Hollow walls may be calculated either in this way or by taking the actual thickness of the parts.

Some contractors do not bother to make out accurate material lists for those items of material that are readily procured from local dealers' stock. They rely on ordering quantities as the work proceeds and then, near the end of the job, figuring what will be needed to complete the work.

The standard-size brick is  $2\frac{1}{4}" \times 3\frac{3}{4}" \times 8"$ . However, the exact size will vary, depending upon the manufacturer's standards. Common brick are the ordinary red variety seen everywhere. They are thoroughly fireproof and strong and are suitable for every place in which brick can be used, except where appearance is important.

Face brick, which are more uniform in size and shape than common brick, come in many colors and shades and surface finishes. Glazed and enamel brick, which are very true to size, are coated with one of several kinds of glazing material in the process of manufacture. Firebrick are made of a special type of clay, highly resistant to heat, and are used in chimneys, fireplaces, fireboxes, etc.

Bricks appearing in the wall in common fashion are called "stretchers"; those laid with an end exposed are termed "headers." Stretchers turned up on end are called "soldiers" and headers on end are called "rowlocks." *Common bond* consists of five courses of stretchers and one of headers, alternately. *English bond* consists of alternate courses of stretchers and headers. *Flemish bond* consists of alternate stretchers and headers in every course.

Bricks used in arches are laid with tapering joints or, for exposed arches where the appearance is important, bricks ground to shape are used.

The standard concrete block is 8" high by 16" long in face measurement. They are made in 3" to 12" thicknesses. Stone or gravel is still used as the coarse ingredient in the manufacture of concrete blocks, but cinders form the aggregate in most of the concrete blocks now made. Cinder blocks are lighter in weight and more insulating and fire-resistive, and they may readily be nailed into.

Portland cement is composed of finely ground limestone and a clay containing silica, alumina, and iron. This mixture is burned at a high

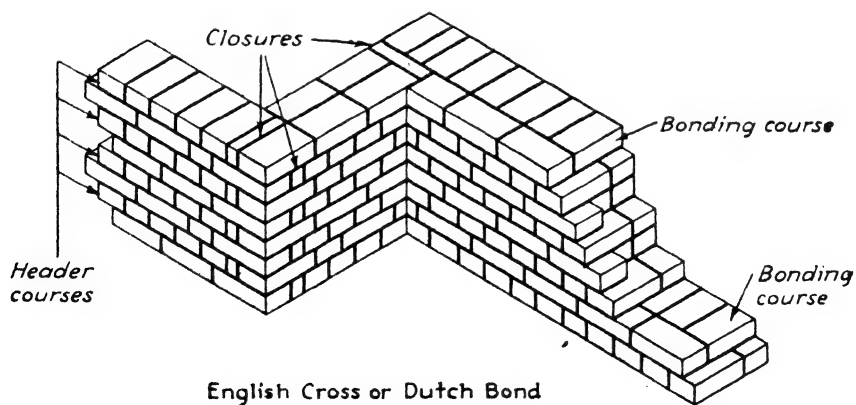
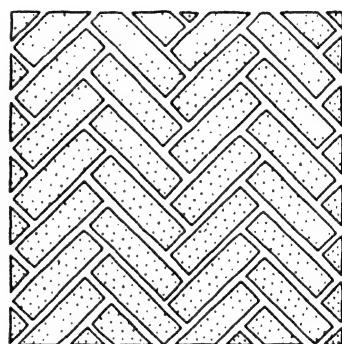
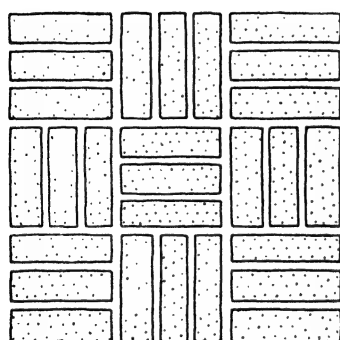
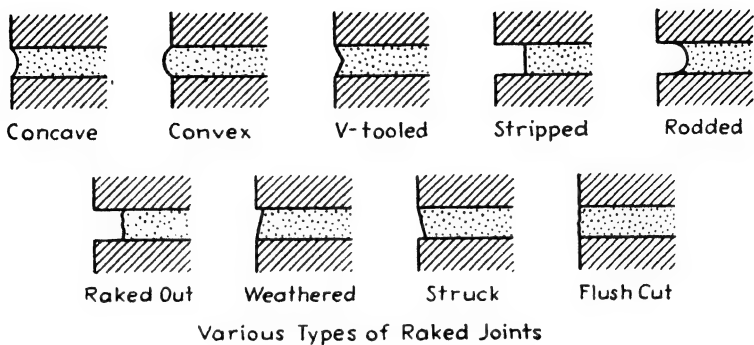
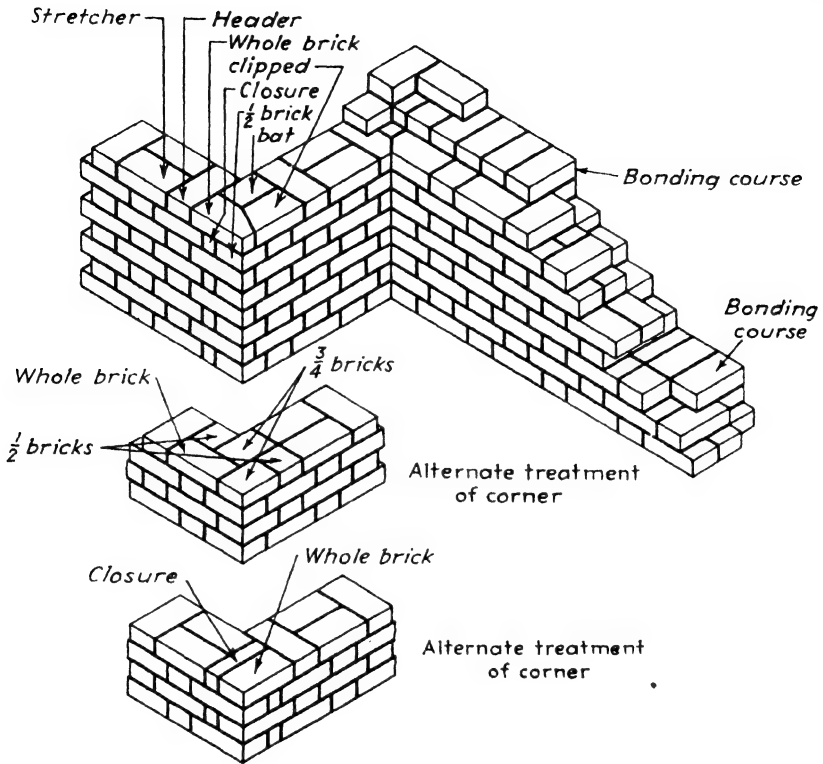
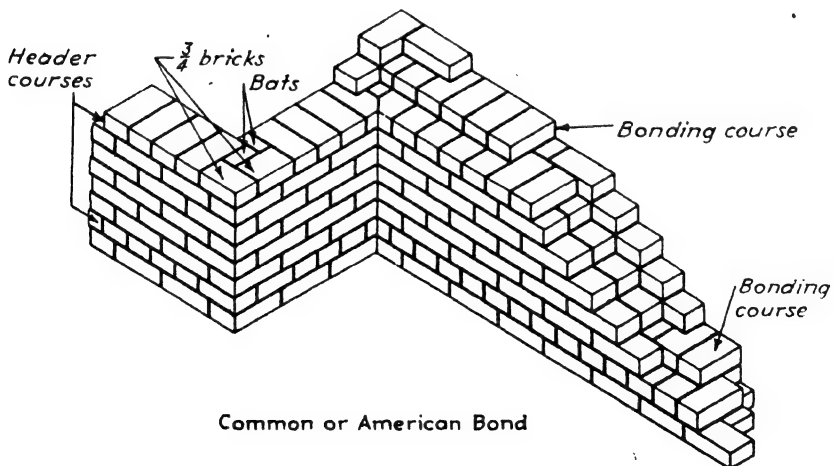


FIG. 74.—Brick



Flemish Bond



Common or American Bond

construction.

temperature and then pulverized. Standards of the American Society for Testing Materials are generally followed in the manufacture of this popular material. It is made in many parts of the country and comes in 94-pound lots, in cloth and paper bags. Special types of cement also are made, such as masonry cement, high-early cement, waterproofed cement, etc.

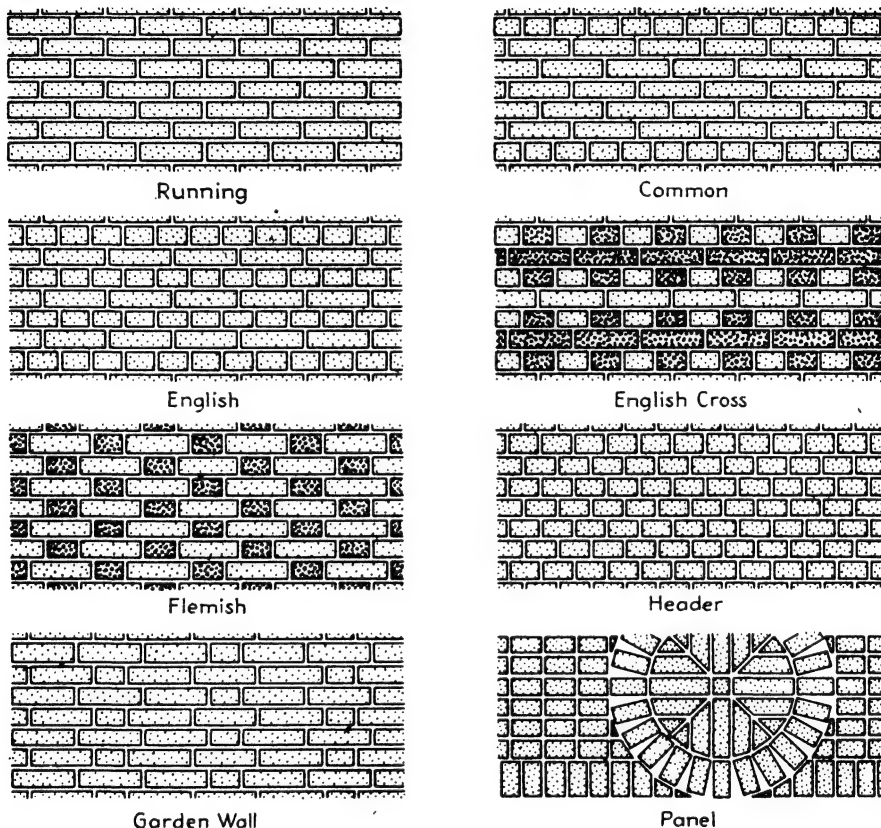


FIG. 75.—Brick bonds.

Mortar is a mixture of cement, sand, and water, usually about 1 part cement to 3 parts of sand. In order to make the mixture more workable, lime is generally added, especially when the mortar is to be used by bricklayers and spread with a trowel. A good mortar for brickwork is also made of 1 part cement, 1 part lime, and 6 parts sand. Mortar forms the material used for cement finish work, as well as for binding masonry.

When the specifications call for a certain grade of brick, hollow tile, or other material, the estimator must watch out to see that quotations are based on the quality called for. A quotation for just "brick,"

"hollow tile," etc., does not bind the dealer to deliver any but the poorest quality. If a better grade is required, the wide-awake estimator will check, to be certain that the prices quoted will cover the materials actually desired. Also, as there is usually more breakage in using poor-

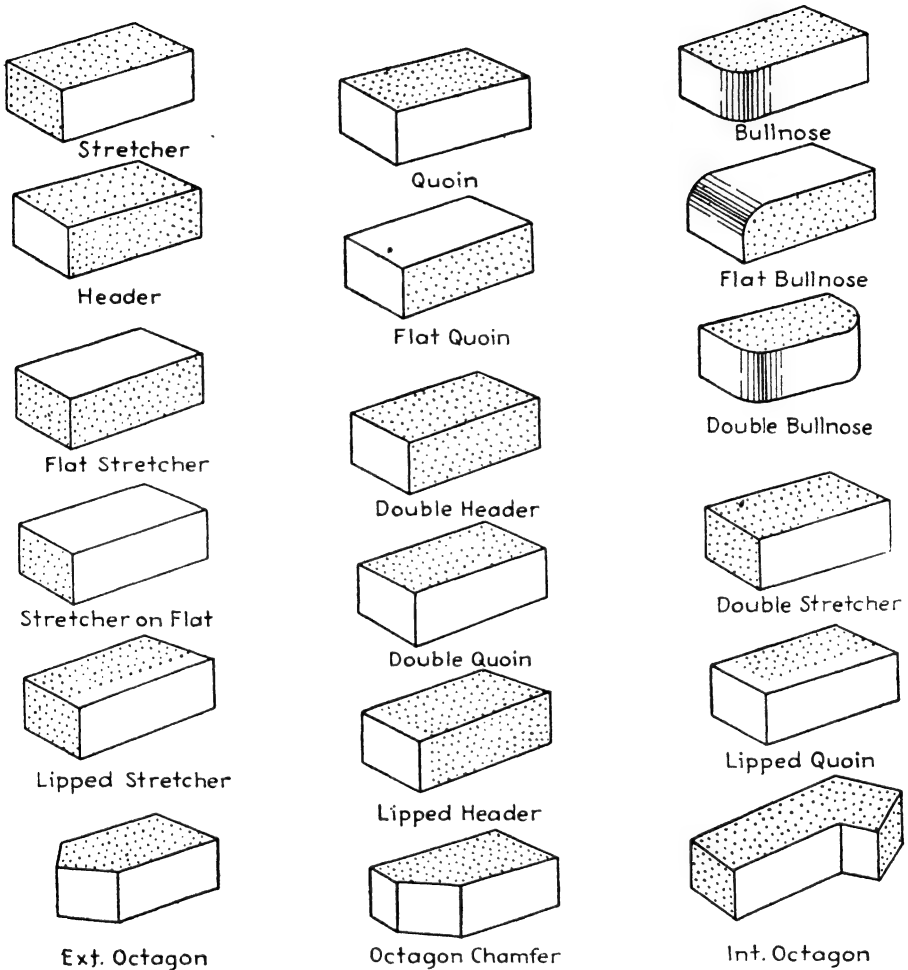


FIG. 76.—Types of enameled brick.

grade materials, he will consider this in his unit prices or make an entry for breakage or other forms of waste that the particular materials, of whatever quality, will probably entail. If face brick are specified to cost a certain price per thousand, it should be ascertained whether the specifications allow for taking the trade discount, if there is any, or whether this is to be passed along to the owner in the accounts of the job.

On important jobs it is customary to send samples of all the main materials to the architect or to testing laboratories before they may be ordered. Often the cost of the tests is to be borne by the contractor. These call for entries in the estimate for packing and shipping, test fees, etc.

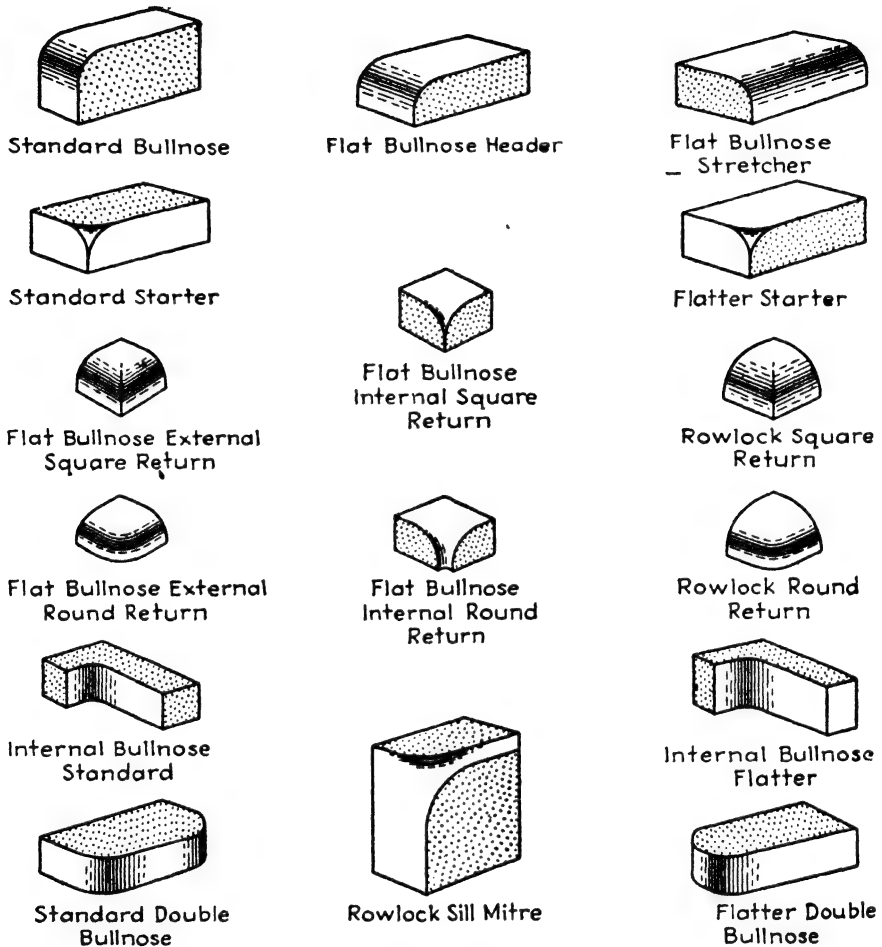
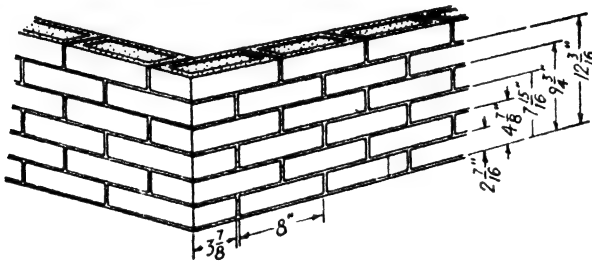


FIG. 77.—Bullnose enameled brick.

Scaffolding for masonwork is an important item of cost and must always be provided for. Some contractors raise the unit price between \$2 and \$3 per M, to take care of all scaffolding for brickwork. This method is satisfactory, if the proper amount is used, for regular work. Construction out of the ordinary, however, should be separately studied as to the scaffold and hoisting requirements; with the amount of material,

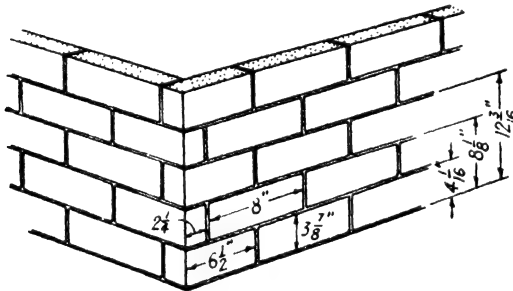
labor, and expense entered in detail, if necessary, in order to provide the money value of this work.

The quality of the work will affect the unit cost of labor. A bricklayer will lay 1,500 brick per day in ordinary work; but, if high-quality workmanship is called for, he will not lay over 1,000 per day. This difference, together with the resultant extra cost of insurance, etc., will have a great effect upon the total cost of the job. Careless estima-



Standard Size

Approximately  $7\frac{1}{2}$  standard brick with  $\frac{3}{16}$ " joint = 1 sq. ft.  
5 brick and 5 joints lay up approximately  $12\frac{3}{16}$ " high



Flatter Size

Approximately  $4\frac{1}{2}$  flatter brick with  $\frac{3}{16}$ " joint = 1 sq. ft.  
3 flatters and 3 joints lay up approximately  $12\frac{3}{16}$ " high

FIG. 78.—Sizes of enameled brick.

tors think of the cost of common brickwork in terms of a certain number of brick per day for all jobs and, thereby, produce an estimate that is not worth the name of estimate; it is merely a rough approximation.

Face brick laid up in regular style is one thing; the same brick laid up in pattern or with special effects may cost two or three times as much for the labor.

Brick walls are cleaned down with a solution of about 15 parts of water to 1 part of muriatic acid. This is applied with stiff brushes by the bricklayers.

Dampproofing, in the form of a tar or asphalt composition, is sometimes applied to the unexposed faces of walls. Fabric dampproofing or

waterproofing is applied to particularly vulnerable locations, such as spandrels, window heads, and parapets. Window frames are generally caulked with an elastic caulking compound.

The fact that an architect fails to state the thickness of masonry partitions does not give the contractor the right to use the thinnest that

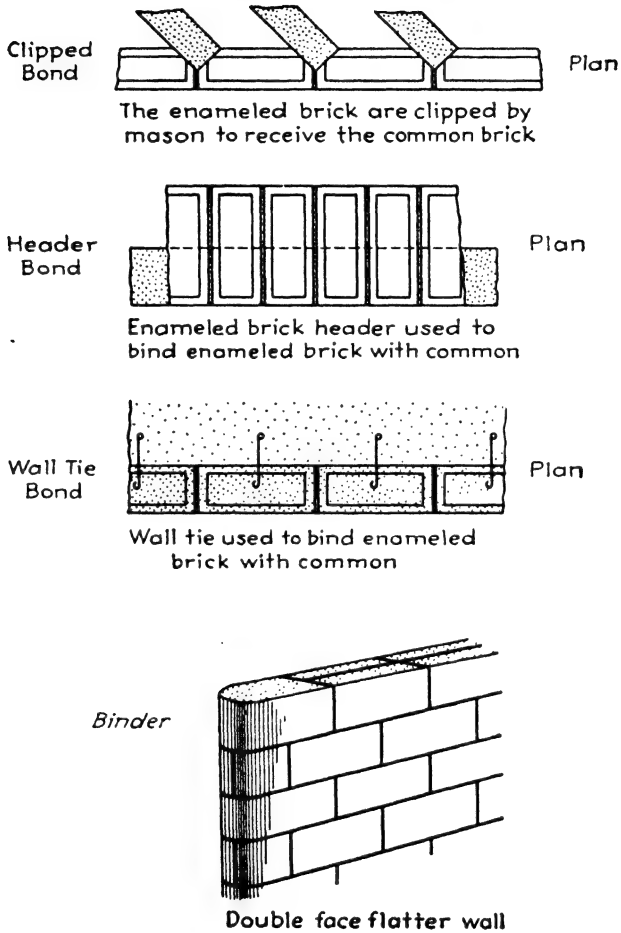


FIG. 79.—Bonding enameled brick.

he can build. Customary practice, and usually the building code also, would demand certain minimum thicknesses. Thus, a 3" partition will be satisfactory if it is not over 12' high, whereas a 4" thickness is usually required for one over 12' high; and, if a great height is involved, the question of thickness should be ascertained, in case it is not noted on the plans. Perhaps a thin partition on top of a thicker one would be approved.

Under the heading of masonwork, rough bucks are sometimes estimated, or at least the setting of them and, perhaps, the side anchors. In any event, it is the estimator's responsibility to provide, in one or another division of his estimate, for bucks, anchors, and the setting of them.

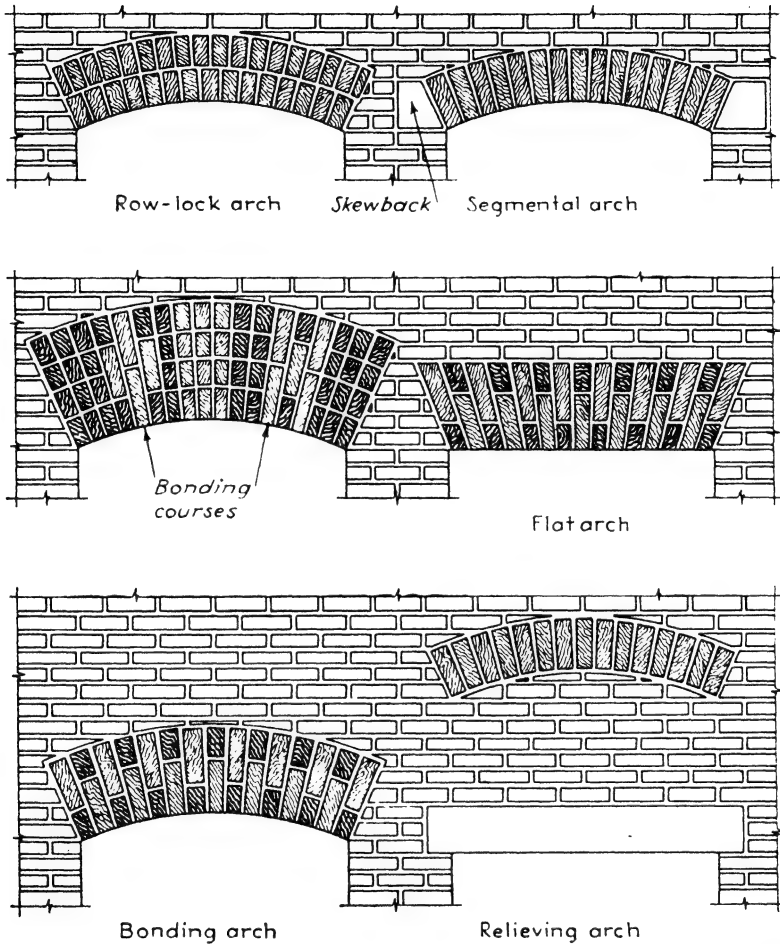
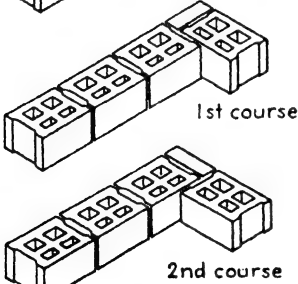
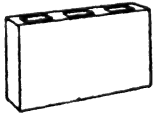
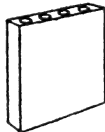
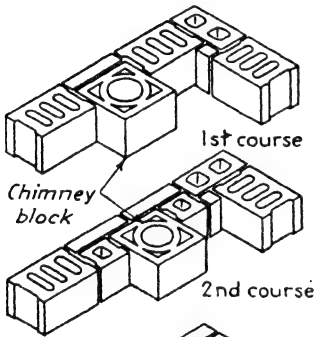
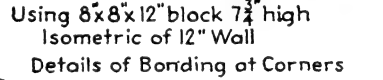
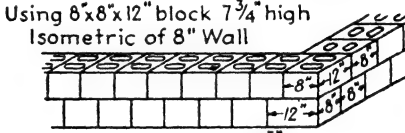
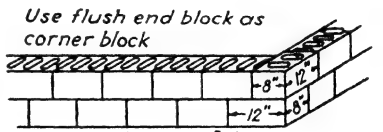
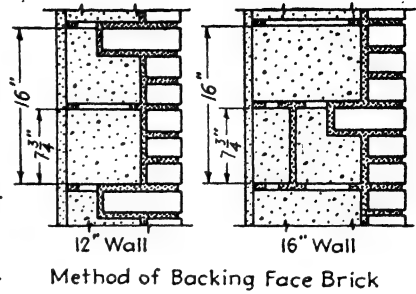
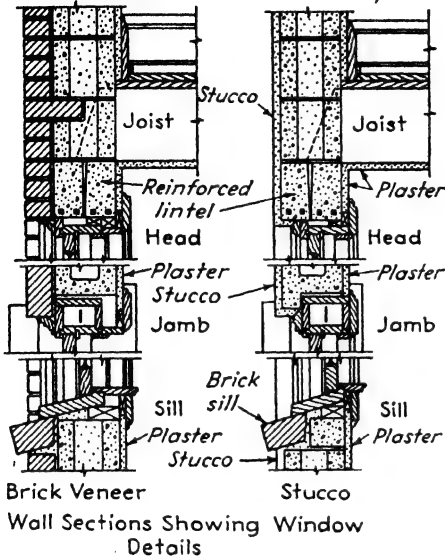


FIG. 80.—Brick arches.

The handling and setting of terra cotta with finished surfaces are, of course, not the same as for ordinary terra cotta blocks. Particular care must be exercised at every stage. The finished material is lifted carefully from the trucks and stacked in accordance with the various sizes and shapes that are to be used. It is then picked out as needed and carefully carried or wheeled into the job to the point of setting. Here the bricklayers set it not nearly as quickly as they would the ordinary

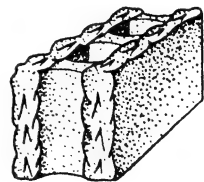
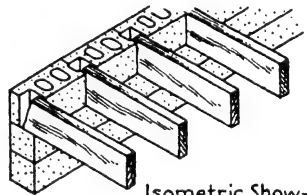


*Note: Metal ties may be used instead of brick header and header back-up block*



Details of Bonding at Corners

Hollow Partition Tile



Block is buttered on outside and inside edges, ribs are left free of mortar Mortar Joints

FIG. 82.—Details of cinder-block construction.



FIG. 83.—Hanging scaffold.

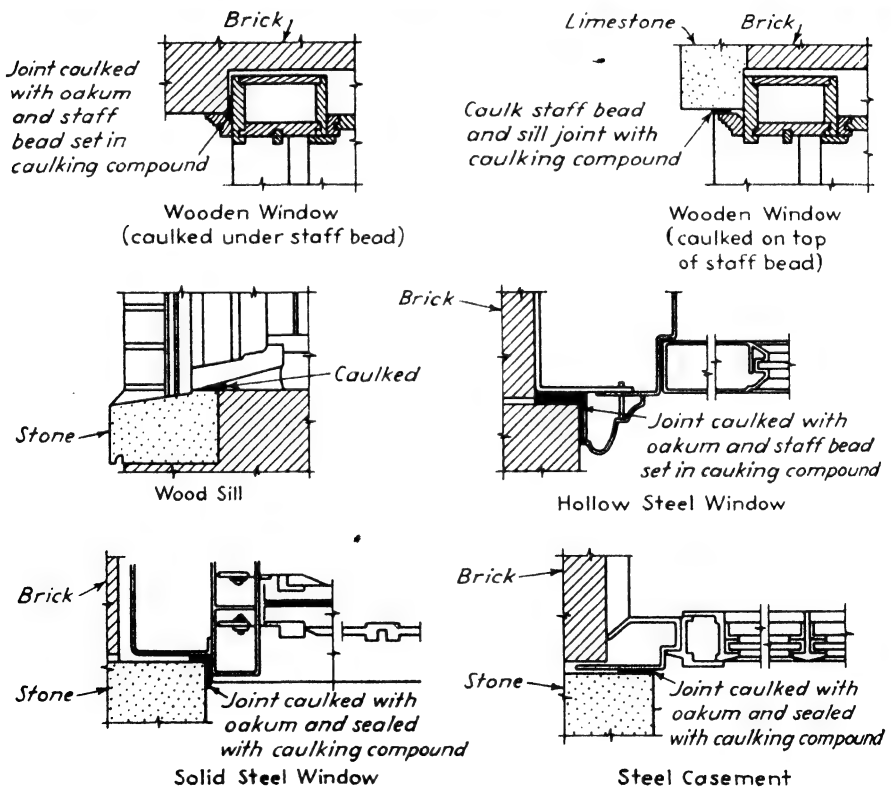


FIG. 84.—Window caulking.

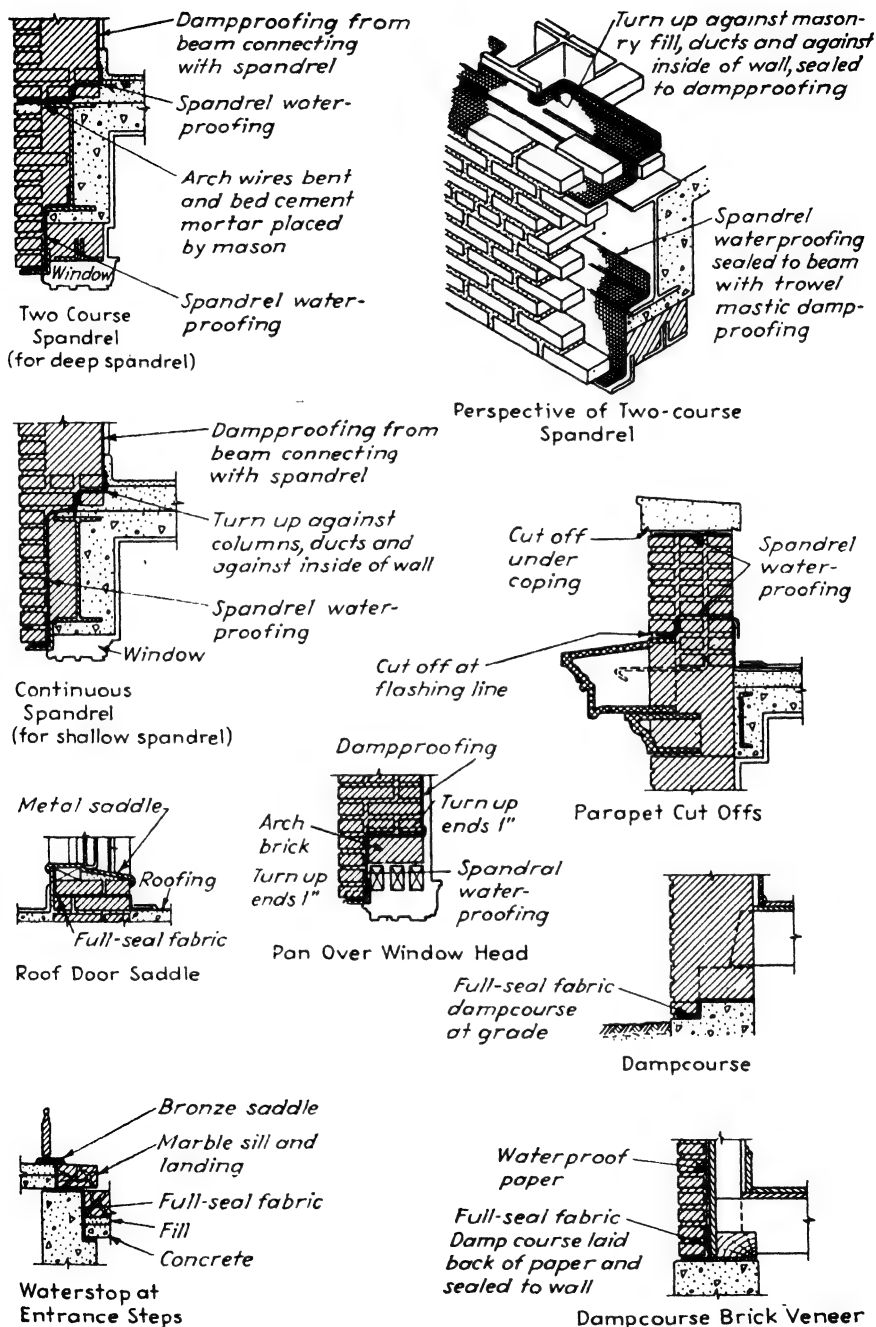


FIG. 85. -- Waterproofing and dampproofing courses.

blocks. It must be treated more nearly like the ceramic tile employed in many shapes and colors in bathrooms, swimming-pool rooms, etc., each piece being carefully placed to suit the design and profile called for on the plans. In fact, it takes the bricklayers about three times as long to set this sort of terra cotta block as it does to set the ordinary kind. Standard shapes and colors of many types are obtainable. Special blocks are made to order and, of course, for these, the manufacturers usually quote for each job separately. Since the blocks are special, the estimator knows that he must take special care in establishing the labor cost also, and not use prices that will fit only standard shapes.

Models are sometimes called for in connection with terra cotta and other materials. Even sample panels of brickwork may have to be built for the architect's selection. These cost the contractor money, and the amount involved must appear in the estimate.

### Exercises

1. Write a list of the materials used in masonwork.
2. State the general method of estimating brickwork.
3. Compute the amount of brickwork in the following solid brick walls:
  - a.  $119'0'' \times 11'6'' \times 1'0''$
  - b.  $63'0'' \times 8'9'' \times 1'4''$
  - c.  $82'9'' \times 10'10'' \times 0'8''$
  - d.  $121'0'' \times 11'6'' \times 1'0''$
  - e.  $68'0'' \times 14'3'' \times 1'8''$
4. Make a schedule of crosshatching indications suitable for masonwork.
5. What is a reveal?
6. Make sketches showing brick stretchers, headers, soldiers, and rowlocks. Mark each by name.
7. Make sketches showing Common, Flemish, and English bonds. Mark each by name.
8. Write at least 300 words of notes on masonwork, taken from one or two of the books listed in the Preface. Name the books used.
9. Make a complete estimate of all the masonwork shown on the house plans. The specifications are stated as follows:
 

Brick shall be thoroughly wet before laying and rubbed into a full bed of mortar completely to fill all joints. Exposed joints shall be struck.

Mortar shall be 1 part cement, 3 parts sand, and  $\frac{1}{4}$  part hydrated lime.

Terra cotta flue lining and smoke-pipe thimbles shall have shells not less than  $\frac{3}{4}$ " thick and shall be sound and straight. Lining shall extend the full length of the flue and extend 3" above the top.

Install a cleanout for each flue, about  $6'' \times 8''$ , located two feet above the cellar floor, with cast-iron frames and doors.

All exposed exterior brick will be textured face brick, selected by the architect. Contractor shall allow the sum of \$37 per M for these brick, delivered to the job. They shall be carefully laid, in Flemish bond, with  $\frac{1}{2}$ " joints.

All other brick shall be common, hard-burned red brick, uniform in shape and size.

All exposed brick surfaces, both exterior and interior, shall be cleaned down with a solution of muriatic acid and water, pointed up where necessary, and left in perfect condition.

## CHAPTER XIV

### ROUGH CARPENTRY

Most estimators prefer to have at least two headings for carpentry work—one for rough carpentry and one for finish carpentry. On large jobs, special headings are set up, besides, for millwork, wood stairs, wood flooring, kalamein work, and other divisions of carpentry, in order to provide for separate total prices for these items or to make comparison with subcontract estimates that may be received for them. Even on small jobs, it is good practice to split up the work in this way.

Rough carpentry takes in all the framing and plain boarding. Finish carpentry includes the trim, mouldings, baseboard, windows, doors, cabinets, shelves, etc. Wood flooring and wood stairs are included in finish carpentry unless special headings are set up for them. Finish hardware also is placed under Finish Carpentry, but on larger buildings this is generally given a separate heading. Frequently, a lump-sum allowance of money is specified for the purchase of the hardware. Of course, any item that is provided for elsewhere in the estimate does not require handling under any of the carpentry headings.

**Lumber** is a general term. Pieces of large cross section are called "timbers." Small stuff is referred to as boards, studs, planks, flooring, mouldings, etc. Lumber comes in many grades, which are established mainly by trade associations. Spruce is used for beams, studs, rafters, sheathing, etc. It is nearly white in color and withstands exposure to weather. Short-leaf pine, often called "N.C. pine," is used for the same purposes as spruce. It is yellowish white with noticeable annual rings and is strong and durable. Fir, a wood somewhat like pine, is used for the same purposes as pine. Other kinds of wood used in building work are long-leaf pine, white pine, maple, oak, and cypress. Oak, maple, and pine flooring are the most commonly used of the wood floorings.

Standard stock sizes and lengths are well established in carpentry. Beams and rafters for general building construction are 2"  $\times$  8", 2"  $\times$  10", 3"  $\times$  8", or 3"  $\times$  10" in cross section, and regular stock ranges from 10 to 20 feet in lengths of 10, 12, 14, 16, 18, and 20 feet. Longer lengths are not readily obtainable in all lumberyards. Studs measure 2"  $\times$  3" or 2"  $\times$  4" and are stocked in the same lengths and also in 9- and 13-foot lengths.

Boards are generally of stock 1" in thickness and from 2" to 10" in width. If they are surfaced (dressed) on one side, they finish about

$\frac{7}{8}$ " thick; and when they are surfaced on two sides, they become about  $1\frac{3}{16}$ " thick. Boards less than 1" thick are counted as 1" thick.

Tongued-and-grooved (T&G) sheathing boards are termed 1"  $\times$  4", 1"  $\times$  6", and 1"  $\times$  8", but they actually measure less than these dimensions and, when laid, they cover about  $\frac{3}{4}$ " less width of space, per board. This is because of the milling to form the tongues and grooves and dressing to form straight and true surfaces. The narrower the board, the higher will be this percentage of loss. With T&G sheathing, underflooring, and finish flooring, and with shiplap boards, shingles, etc., the milling, overlaps, and other elements of "waste" must be taken into account, as they run up to a large percentage in some cases.

The Government and several of the large national lumber associations have developed official grading rules for lumber. Thus one speaks of Select Structural material in certain types, and No. 1 Common, 1200# Douglas Fir, B-Grade lumber, etc. If it is so ordered, the material is officially grade marked.

The ordinary Yard Lumber obtainable at all lumberyards is graded as No. 1 Common and No. 2 Common shortleaf pine or fir and is used for ordinary framing purposes. Structural material, such as is graded Structural Douglas Fir or Structural Southern Pine, is used where a stronger material is desired, as for girders and beams. Shop Lumber, used for doors, windows, trim, etc., is graded A, B, C, or D.

Framing lumber is 2", 3", and 4" thick for ordinary studs, beams, etc., although, as a result of the sawing, the actual thickness is about  $\frac{1}{2}$ " less. Likewise, 1" boards measure nearer to  $\frac{3}{4}$ " thick. The depth of beams, etc., also is short of the figured dimensions, because of the sawing in the mill, and a 10" beam usually measures only about  $9\frac{1}{2}$ ". However, for figuring the amount of board feet, the full dimensions of the lumber stock are always taken.

Southern yellow pine and Douglas fir are the two most commonly used kinds of lumber for general building purposes. White pine, white-wood (poplar), and birch are in considerable demand for trim and other exposed work, white pine being preferred for outside items. Oak, pine, and maple, as has been noted before, are the most popular woods for flooring.

The highest grade of yellow pine or Douglas fir is called "select structural," the next is "dense heart," and the next lower grade is "structural square edge and sound." Unfortunately, the lumber associations have made a poor job of names and they are very misleading and tricky. The estimator must beware and note the full wording of specifications, quotations, etc., referring to the grades of the material.

The lowest grades of framing lumber, even if specified, are seldom worth using, because of the great waste in them. This waste involves

handling in order to unload and stack the material that will later be discarded, the culling out that must be done by the carpenters, the rehandling, and the final disposal. Such poor material is often the cause of friction between the contractor and the architect, as the architect desires to see good materials used on the job. This causes extra expense for taking out the poor work and replacing it with new material of better quality.

Lumber that is 5" and larger in its least dimension is classed as timber; 2" and under 5", as dimension lumber. It comes to the job usually planed either on one side and one edge or on all sides. Terms such as D1S2E, S4S, meaning that the material is dressed, or surfaced, as noted, are used to designate the faces that are finished faces. Because of the saving in shipping space, very little additional is charged for dressed lumber over rough lumber. For this reason, and also because it is easier for the men to handle smooth material, lumber dressed on all four sides is preferred.

Floor beams 2" × 10" × 14'0", wall and partition studs 2" × 4" × 8'0", boards 1" × 6" × 16'0", and other such expressions are used regarding the size of lumber. The dimensions in inches of cross section by the length in feet are given. Thus 2" × 10" is the cross section of the floor beams mentioned above, and 14'0" is the length. This is the standard way of expressing the size of lumber.

By writing the standard dimensions of lumber over 12, in the form of a fraction, the number of board feet of lumber in the piece is readily found. Thus the board feet in a floor beam of the size noted would equal  $\frac{2 \times 10 \times 14}{12} = \frac{280}{12} = 23\frac{1}{3}$  BF. In cases of more than one piece, simply multiply the amount found in one piece by the number of pieces concerned.

The rule is: place the standard dimensions over 12, and multiply the answer by the number of pieces concerned. If there are 50 beams 2" × 8" × 16'0", the expression would be as follows:

$$50 \times \frac{2 \times 8}{12} \times 16 = 1067.$$

For every linear foot of 2" × 8" there are  $1\frac{1}{3}$  BF, for every linear foot of 2 × 6 there is 1 BF, for every linear foot of 2 × 4 there is  $\frac{2}{3}$  BF. This can readily be seen, because  $\frac{2 \times 8}{12} = 1\frac{1}{3}$ ,  $\frac{2 \times 6}{12} = 1$ , and  $\frac{2 \times 4}{12} = \frac{2}{3}$ . The same holds true for all lumber.

**Rough carpentry** is the name given to framing, or structural carpentry. However, there is no definite line of demarkation between rough

and finish carpentry. An estimator arbitrarily puts the carpentry items under either heading or under other headings for special portions of the carpentry work, to suit his own convenience, although, if a specification is well arranged, he is likely to follow it in arranging his estimate.

Architects frequently include many miscellaneous items under the heading of carpentry in their specifications, for want of a better place for them or for the sake of avoiding the necessity of setting up special

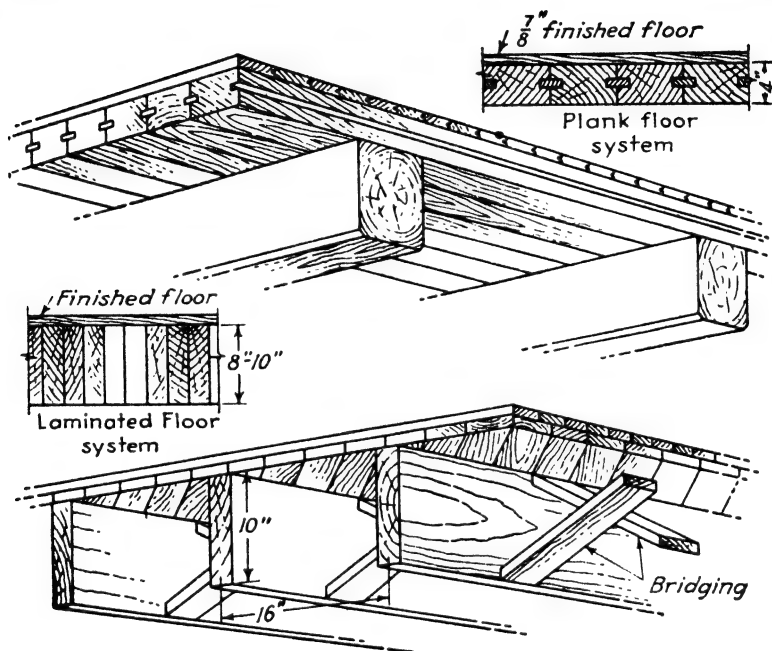


FIG. 86.—Mill construction and ordinary floor compared.

headings. Metal doors, insulation, and fixtures of various kinds are often found in the carpentry specifications. This is one division of the specifications that estimators practically always expect to break up into several estimating divisions—some of the items even finding their place in the general job expense division.

**House Framing.** The common method of framing a house is called "balloon" framing. In this type, the wall studs extend all the way from the foundation sill to the plate that supports the rafters and the attic floor beams (country carpenters use the term "joists" for beams and rafters, and sometimes also for studs). In the braced-frame type, the wall studs are only one story in height and the second-floor beams (or joists) are carried on a regular plate, formed usually of two  $2 \times 4$ s, instead of being carried on a ledger board cut into the studs, as is the case in balloon framing. There are other differences between these two

types of framing and, of course, a combination of methods can be used too. There is usually no difference of opinion about the balloon type's being satisfactory, provided that it is well put together and that the sheathing is applied diagonally, so as to brace the structure better than would be the case if the sheathing were applied horizontally.

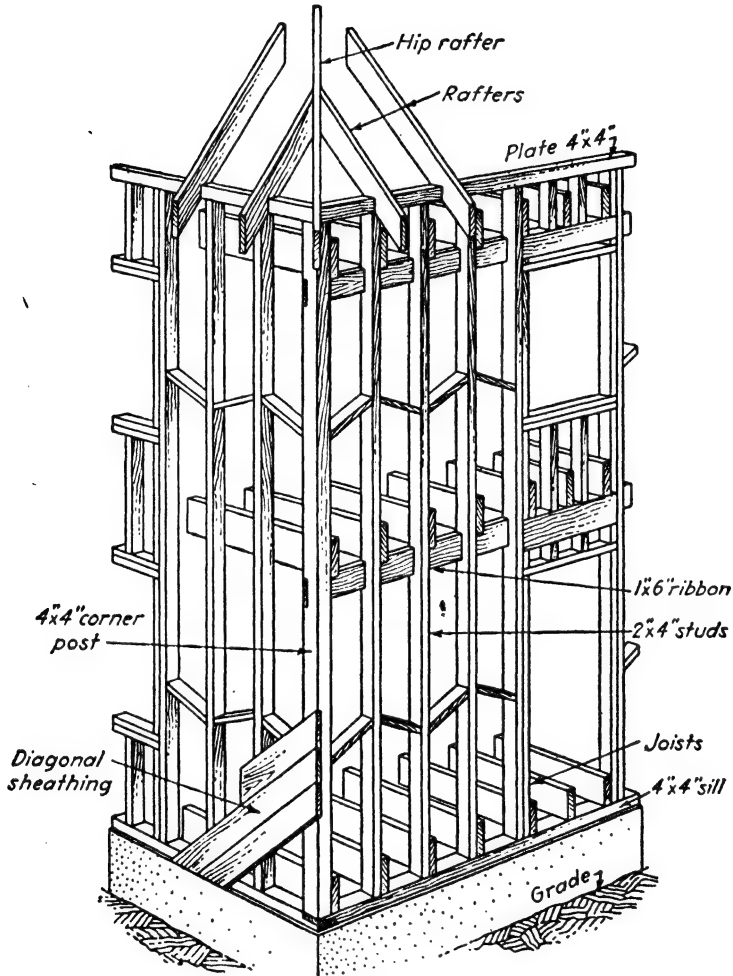


FIG. 87.—Balloon frame.

Another type of framing is called "mill construction." As the name implies, this type is used principally for mills and similar structures. Genuine mill construction consists entirely of heavy timbers of large cross section, not only for the framing but for every member used in the building. The flooring is 3" or 4" thick T&G, or the same thickness of square-edged material laid on edge.

The construction of the framework for all houses is practically the same, regardless of whether the exterior is wood, stucco, or brick veneer. Upon good lumber properly used, together with accurate workmanship, depends the ultimate success of the completed building.

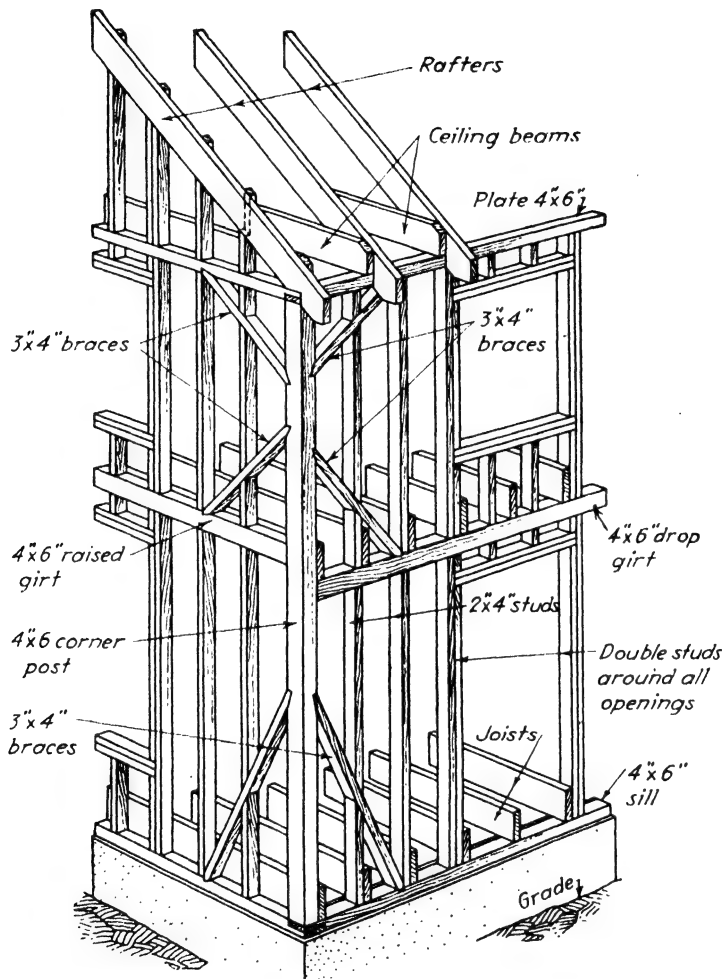


FIG. 88.—Braced frame.

The outside of the house, which is subjected to sun, wind, rain, and snow, must withstand severe usage. Exterior wood should be of a decay-resisting species that will hold tight at the joints and will take and hold paint. It should be thoroughly seasoned material. Siding, cut in various patterns, is made in sizes ranging from  $\frac{1}{2}$ "  $\times$  4" to  $\frac{3}{4}$ "  $\times$  12" and is available in western red cedar, Idaho white pine, northern white pine, and ponderosa pine. In applying siding, all joints around window

frames and corner boards or at mitered corners should be carefully fitted. Spliced joints should be tight, to prevent the infiltration of moisture. No spliced joints in three consecutive boards should be directly over one another. Proper nailing with the right-sized nail is important. The nailheads should be set into the wood and the holes filled with putty after the first coat of paint has been applied. All exposed woodwork should be given a coat of priming paint as soon as it is in place.

In localities subject to termites and at points of construction exposed to fungus growth, chemical treatment may be necessary for the lumber, particularly any that comes into contact with masonry foundations.

Wood girders may be built-up or solid. While either type may be used, built-up girders are preferable, because of greater strength, size for size; less shrinkage, owing to the complete seasoning possible with thinner stock; and greater ease of installation. Members of built-up girders should be spiked together securely.

Joists are normally spaced 16" O.C. (on centers), except where additional strength is required for some particular area, in which case the joists (beams) are doubled or extra joists are set between the regular ones so as not to interfere with lathing. Spacing of 12" will also conform to lathing requirements. Floor and roof beams must always be doubled or tripled around openings, such as those for stairways, shafts, hearths, etc. This does not always show on the plans, nor is it mentioned in all specifications, but it is required by good construction and by building codes. Similarly, floor beams are doubled under partitions, or larger beams are used there, to carry the extra load imposed by the partitions, unless, of course, the partitions are low or of very light construction, like wood-and-glass office partitions.

In exterior walls of one- and two-story houses, the studs are customarily 2"  $\times$  4". In buildings over two stories high and in cases of exceptionally high ceilings, studs should be 2"  $\times$  6" or larger.

Rafters are normally spaced 16" O.C., since this permits setting them directly over the wall studs and nailing each one to the side of the ceiling beams. Thus the frame is tied together and spreading of the walls is prevented. This spacing also facilitates lathing the underside of the rafters, if a plaster ceiling is required under the roof.

All partitions should be framed with 2"  $\times$  4" studs, spaced normally 16" O.C., except where thicker walls are required on large work for structural purposes, or where plumbing and heating pipes and vent ducts are to be concealed, or where architectural effect must be considered.

All anchors for sills, plates, etc., built into the masonry before the framing is erected, should be included in the concrete or masonry divisions of the estimate. All the plates, ties, stirrups, etc., that are attached to the wood framing, however, should be listed under rough carpentry.

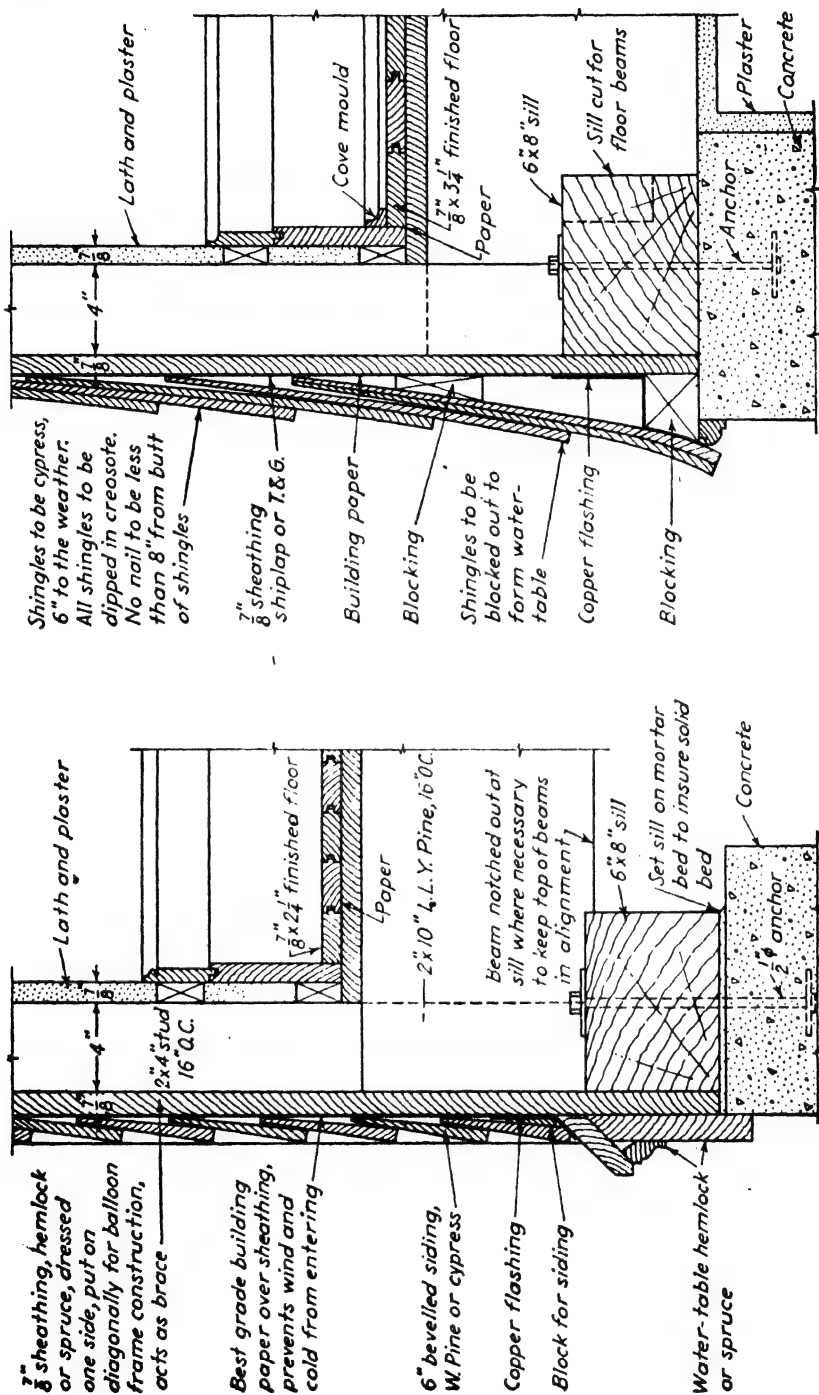


Fig. 89.—Sections through water tables—wood buildings.

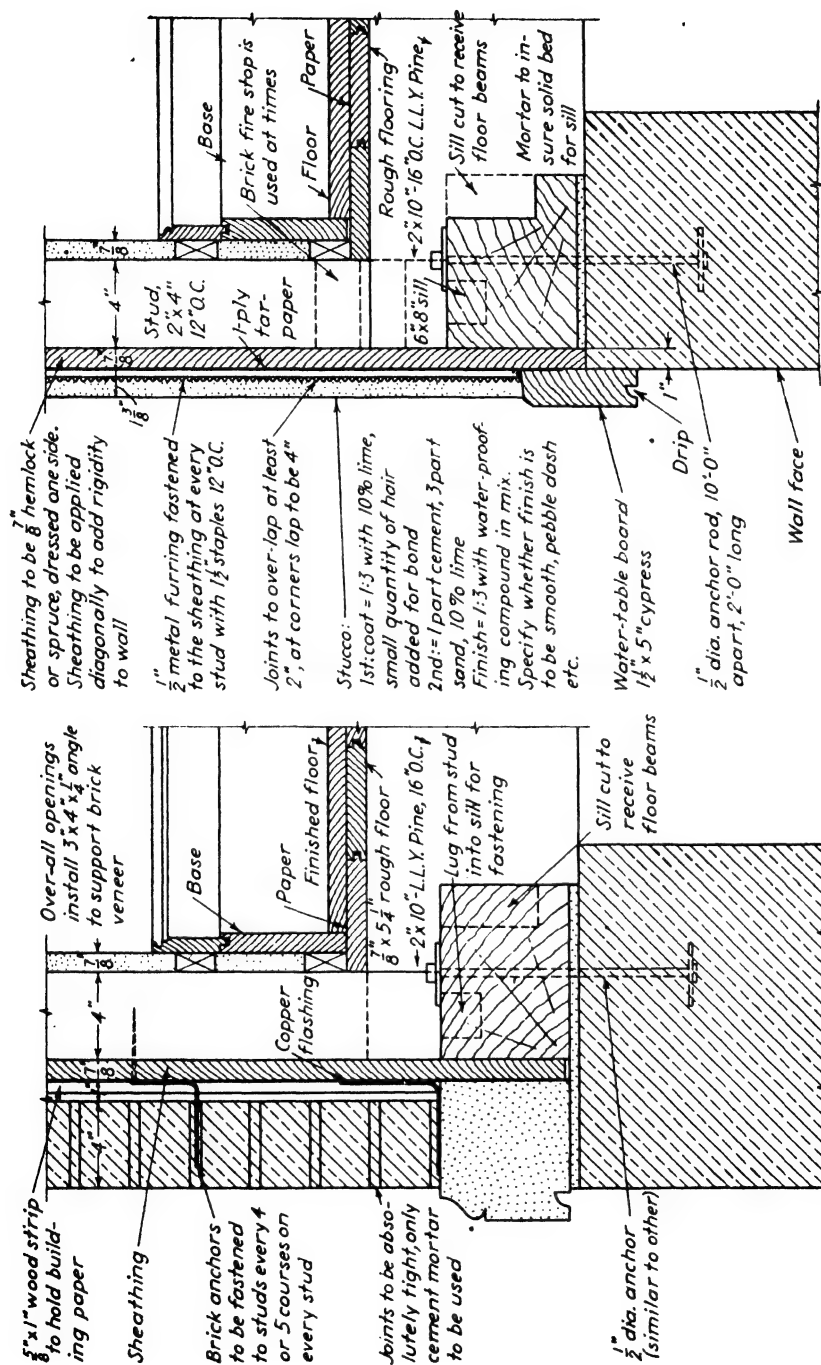


FIG. 90. - Water tables, masonry, and stucco.



Diagonally applied sheathing on walls adds greatly to the strength of the wall, over the use of horizontally applied sheathing, especially if at every bearing it is well nailed with three nails instead of the more customary two nails.

Figure 103 shows the beginning of a rough-carpentry estimate for a house. For frame construction the number and sizes of all the pieces

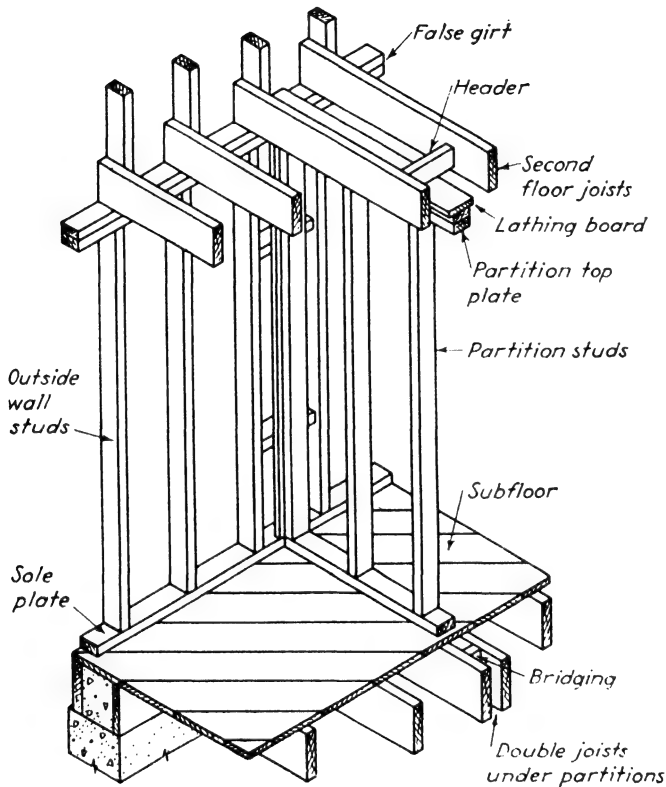


FIG. 93.—Bearing partition.

are listed wherever possible. Thus, the sill that is placed on top of the foundation wall is listed as so many linear feet of the size of cross section that is called for, as 126' of 4"  $\times$  6". The corner posts, which occur at every angle of the building, are listed separately from the ordinary wall studs. Corner posts are sometimes specified to be solid pieces, as 4  $\times$  6 or 6  $\times$  6, or made up of several pieces spiked together. The studs are usually 2  $\times$  4 or 2  $\times$  6. Corner bracing, plates, short studs at windows, etc., must all be listed. Floor beams are counted and listed separately as to cross section and length, care being taken to note those that are

doubled under partitions and around stair openings, etc. Sometimes tripled beams are called for.

Studs, both in walls and in partitions, are commonly spaced 16" O.C.; that is, 16" from the center of one to the center of the next one. However, owing to the spacing of the doors and windows, exact spacing is not always possible and additional studs must therefore be counted, to give

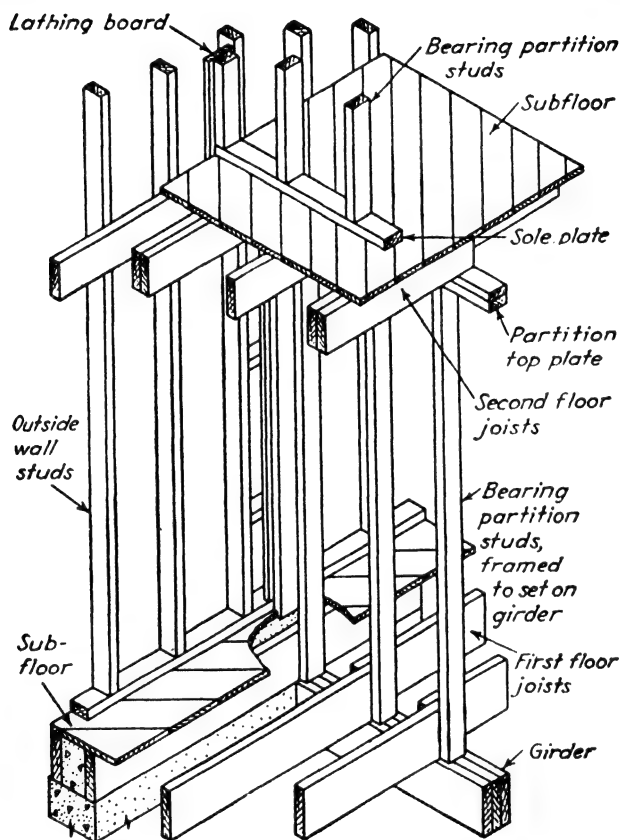


FIG. 94.—Nonbearing partition.

bearing for the lath, etc. Soles, bridging, and plates for partitions should be listed separately from the studs, and care be taken to include them as single or double, in accordance with the particular job being estimated.

Wood framing is usually measured by the board foot and priced per thousand board feet (M'BM).

Bridging is measured by simply taking twice the length of each row, because floor bridging is always doubled, or "crossed." This gives the total linear feet of material required, if it is for beams not more than 10" deep. For beams 12" deep, multiply by  $2\frac{1}{4}$  instead of by 2, and for 14"

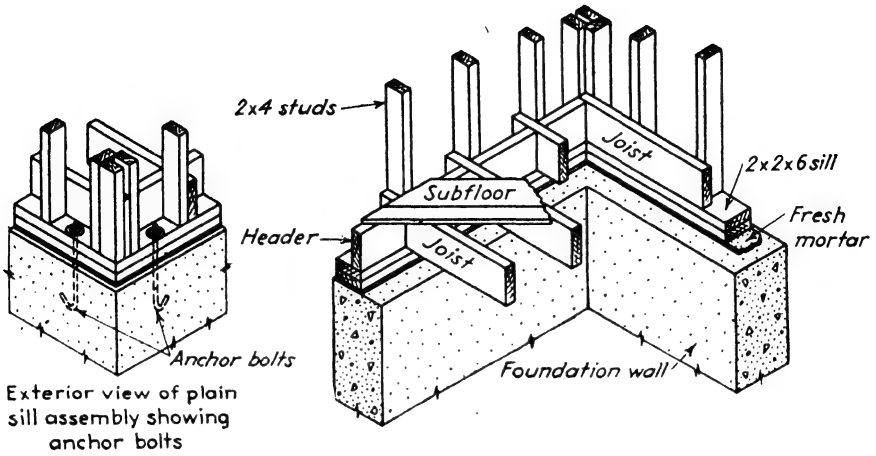


FIG. 95.—Corner conditions.

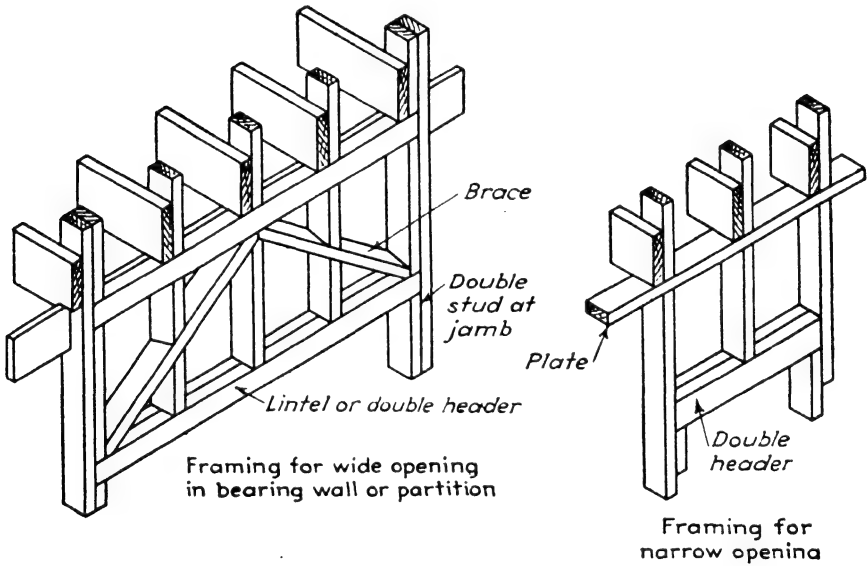


FIG. 96.—Framing over openings.

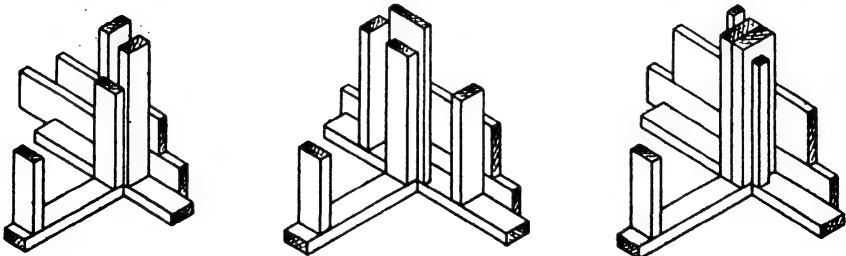


FIG. 97.—Partition corners.

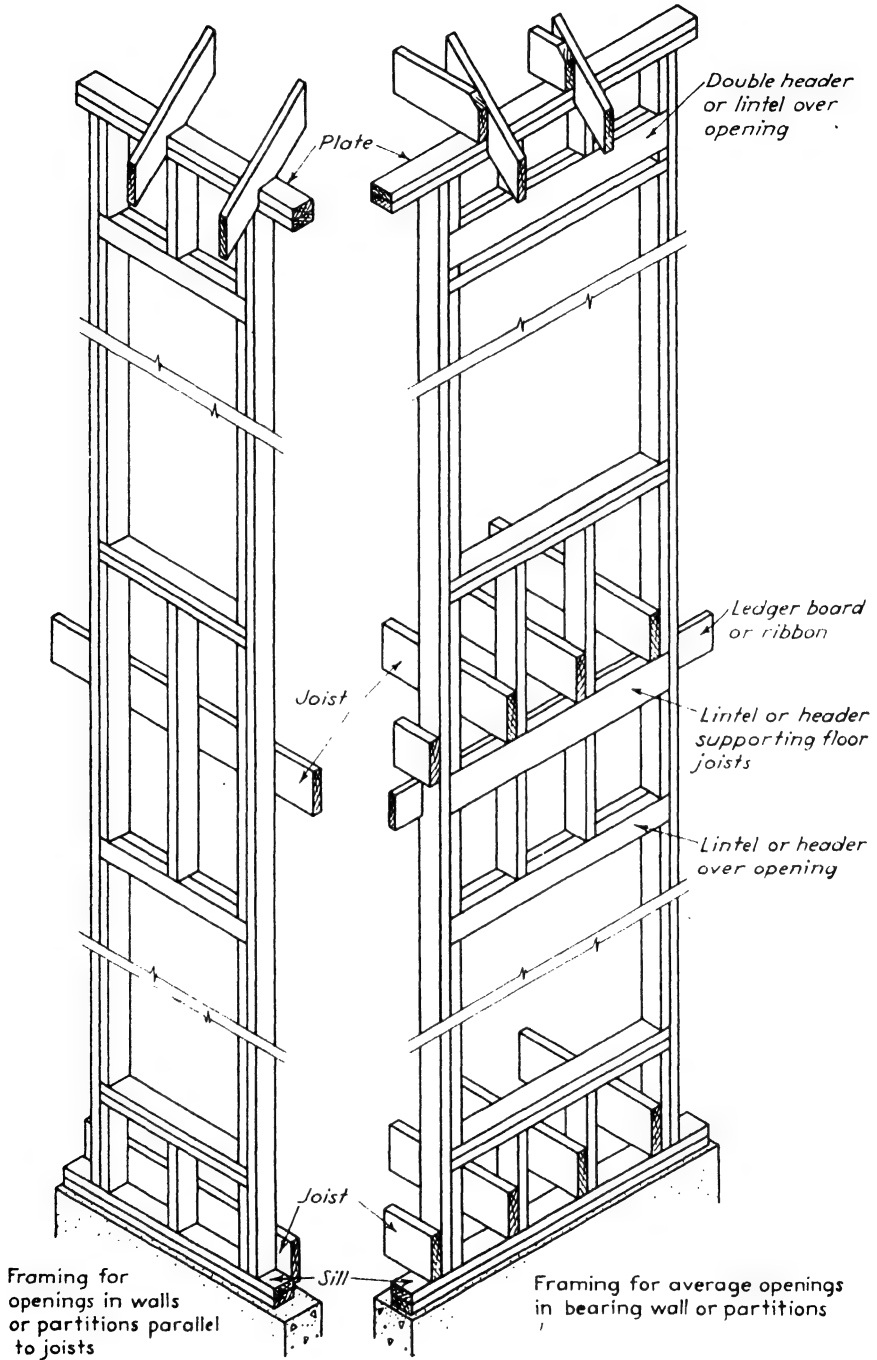


FIG. 98.—Framing around openings.

beams multiply by  $2\frac{2}{3}$ . Bridging is often priced by the linear foot, but if board feet are desired the calculation can be readily made by multiplying the total length thus found by the cross-section dimensions of the material specified and dividing by 12. Thus, 870 lin. ft.  $\times$  1"  $\times$  3", divided by 12 = 218 BF.

Wall sheathing, commonly 1"  $\times$  6" T&G pine or fir, is measured by taking the net area covered and adding for the waste in milling and

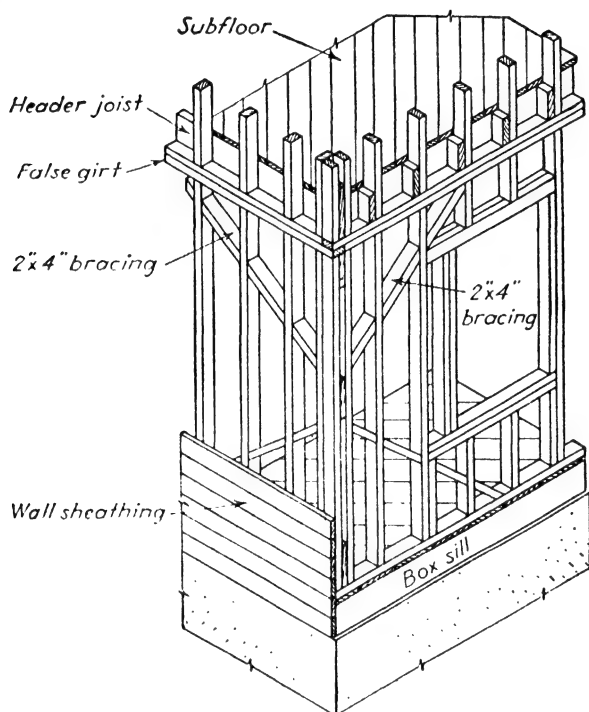


FIG. 99. Corner bracing.

cutting. This waste runs about 25% for 6" boards and 22% for 8" boards.

Building paper is measured by taking the net area to be covered and adding 5% to allow for the laps.

If scaffolding is required for the outside work on walls, even on frame walls, take the gross area of the walls as the quantity, measured from the ground to the top of the walls. This is priced per square foot, usually between 5¢ and 10¢ per square foot.

Framing lumber costs the contractor between \$50 and \$70 per MBM for regular kinds, delivered to the job. The labor of handling, framing, and installing it costs \$30 to \$40 per MBM. This makes a total cost of \$80 to \$110 per MBM, in place, without insurance or general expense

being considered. Heavy and intricate framing may cost much more in both material and labor.

The sheathing of walls and roof and rough flooring costs the contractor \$40 to \$50 per MBM for the material and \$20 to \$25 for labor, or a total of \$60 to \$75 per MBM, in place. This is in board feet, as has been noted. The range would be nearer \$70 to \$90 if expressed in terms of thousands of square feet of surface to be covered. The cost will depend

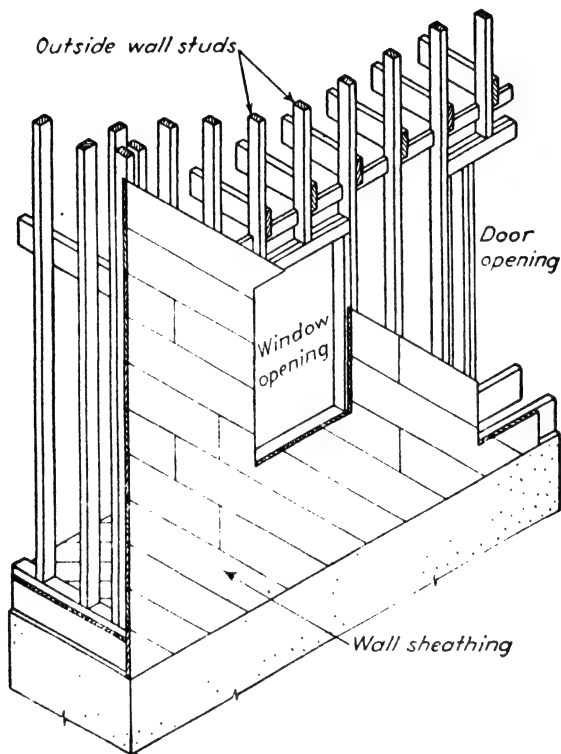


FIG. 100.—Diagonal sheathing.

also on whether the material used is square edged or tongued and grooved, and whether it is laid straight or diagonally.

To the cost of rough carpentry must be added about  $\frac{1}{3}$  keg per MBM for the nails required, if the unit cost does not include the cost of nails.

The element of "waste" is more important in carpentry than in most other divisions of the estimate, especially on account of the grading and trade customs that are established among the manufacturers and dealers in the materials involved. Even lumber that is bought as of good quality, free from large knots, not warped, straight, etc., may become damaged as a result of careless handling in transportation or at

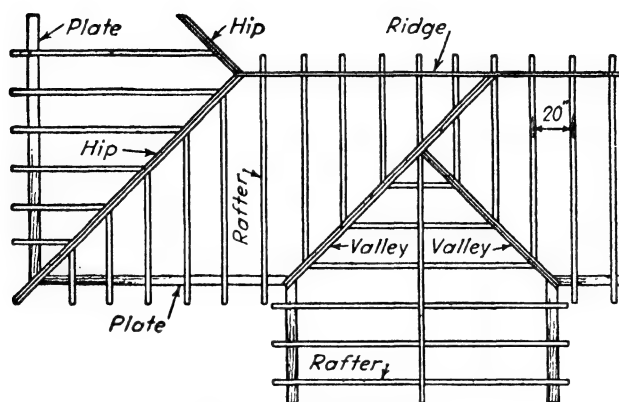


FIG. 101.—Roof framing.

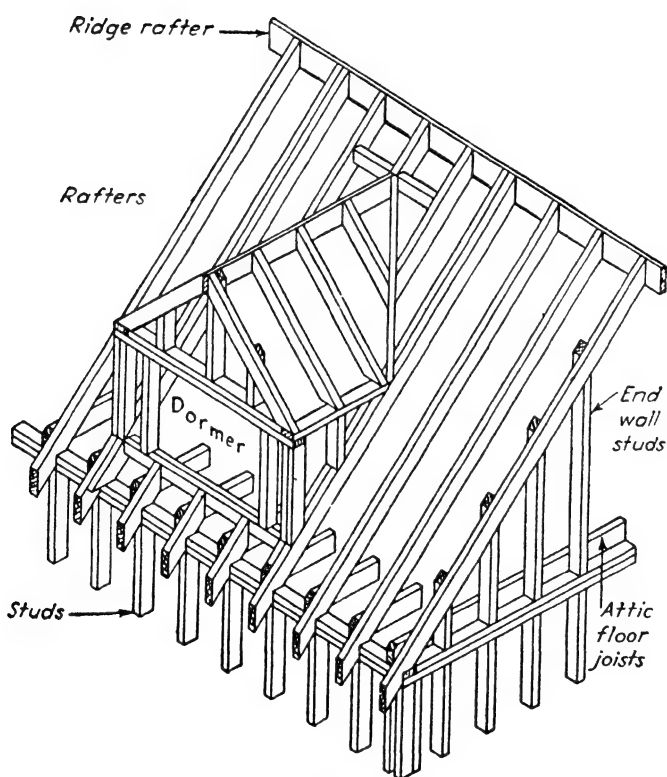


FIG. 102.—Dormer framing.



**The Architect's Attitude.**—Some architects set themselves up as a sort of court of last resort in regard to the judgment of quality of materials, even going so far as to overrule the official grade markings of lumber inspectors, who are supposed to be unbiased. An estimator is forewarned by a specification in which an architect deliberately states that the architect's decision will be final. This usually means that he will be hard to please and will probably act more as if he were paying for the building himself than serving as architect, or third party, to the contract. Despite the so-called ethics of the architectural profession, which claim that architects are fair-minded men, contractors know that many among them are very hard to please and technical and, in general, far from what one regards as fair-minded. Fortunately very few have the reputation of "breaking" the contractor or of "rubbing it in" on every job.

**Temporary Construction.** Temporary enclosures and protection, temporary arch centers, and other temporary construction items are sometimes specified under Carpentry. Sometimes they are not specified at all; but they will be found necessary nevertheless. The estimator must have these in mind on every job, and for this reason some offices use a printed general job expense estimating sheet on which these and other usual expense items are printed, so they will not be overlooked. In any event, the estimator should figure these items just as he would any items of permanent carpentry, and apply unit prices per board foot, per square foot, or in any other suitable manner.

**Special framing** or work out of the ordinary is to be watched carefully and analyzed closely in estimating. Roof trusses, tower framing, and odd-shaped structures belong in this class. New methods of timber framing developed in recent years call for special fastenings that require special tools.

Every piece of lumber in special or heavy framing must be listed; and all the iron bolts, shear plates, connectors, etc., must be counted and listed separately. Special scaffolds and hoisting and bracing are usually involved also. Split-ring timber connectors are made of hot-rolled carbon steel and must fit snugly in prebored holes. Toothed-ring connectors are stamped from No. 16 gauge rolled sheet steel to form a circular, corrugated, sharp-toothed band, welded into a solid ring. Claw-plate connectors are malleable iron castings, each plate consisting of a perforated, circular, flanged member, with three-sided teeth on one side. Shear plates are of pressed steel or malleable iron, with a flange around the edge on one face. Bolts and washers of many sizes also are required in heavy framing.

**Insulation** is fast becoming an essential part of building work. If a separate heading is not provided for it in the estimate, it is usually placed under Carpentry.

Insulating materials are of four types: flexible, rigid, fill, and reflective. The first three are composed of a large number of small cells, amounting to minute air spaces, which resist the passage of heat or cold. The fourth depends upon the reflection of radiated heat.

Insulation should be protected against the penetration of moisture. When there is a great difference in temperature between the inside and the outside of a building, moisture condenses. If the moisture is absorbed by the insulating material, serious damage to plaster and inside finish may result. Some insulating materials lose their efficiency because their porous nature is unprotected against air infiltrating and becoming moist in the insulation, owing to condensation within the wall. Furthermore, loose insulating materials settle and form open spaces or leaks at the top of the walls. Therefore, insulation must be carefully installed so as to remain permanently in place.

Rigid insulating sheets are sometimes used in place of wall or roof sheathing. Many varieties of rigid insulating boards are made, some of which are not suitable to serve as substitutes for sheathing.

Insulation is generally measured by finding the number of square feet of each different kind and thickness required, and building up a price per square foot to suit the material, labor, and conditions in each case.

**Building codes** cover carpentry work. The following are a few extracts from the New York code:

Wood beams and rafters resting on masonry or on girders must have at least 4" bearing. Floor and roof beams must not be supported at their ends on stud

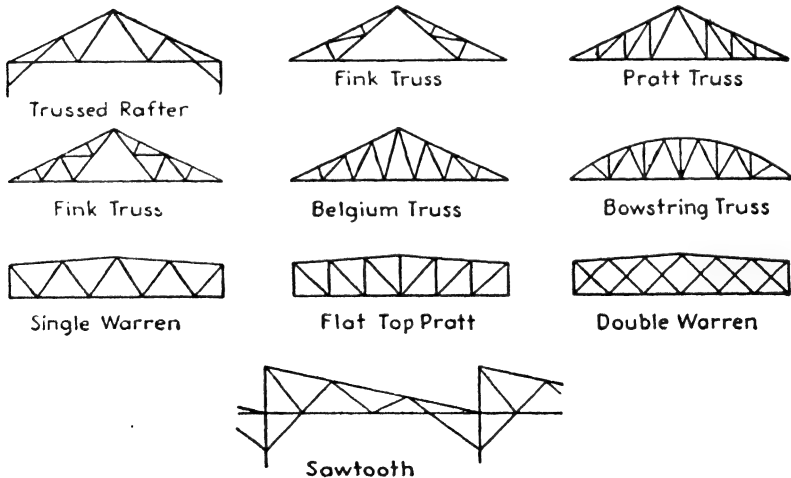


FIG. 104.—Types of trusses.

partitions, except in one- and two-family dwellings. Tail beams over eight feet long and all trimmer and header beams must be supported on approved iron

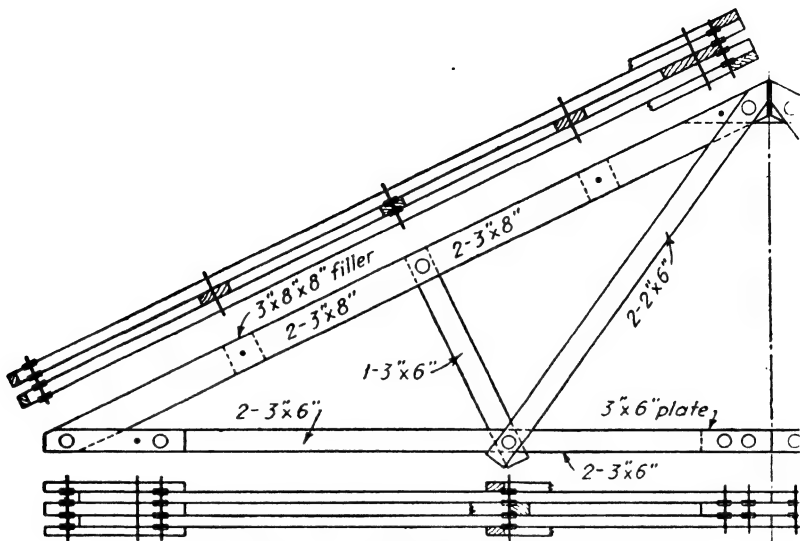


FIG. 105.—Truss with connectors.

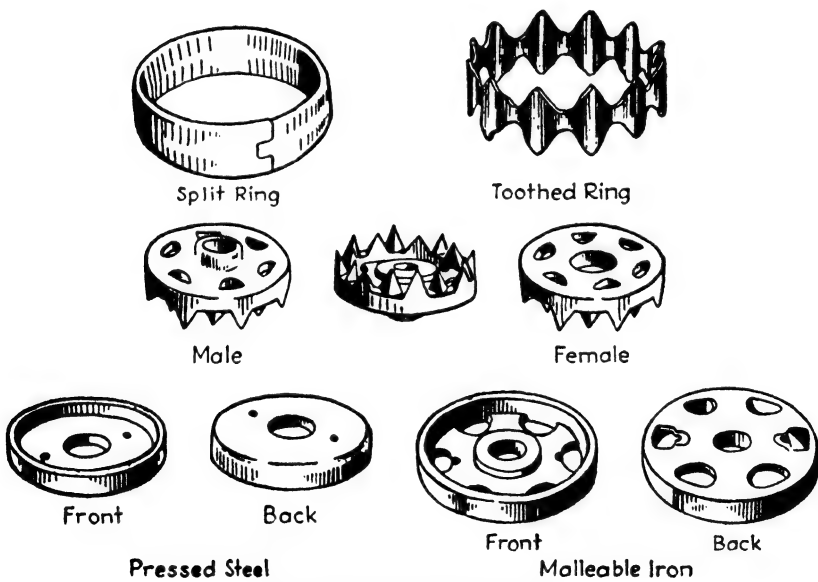
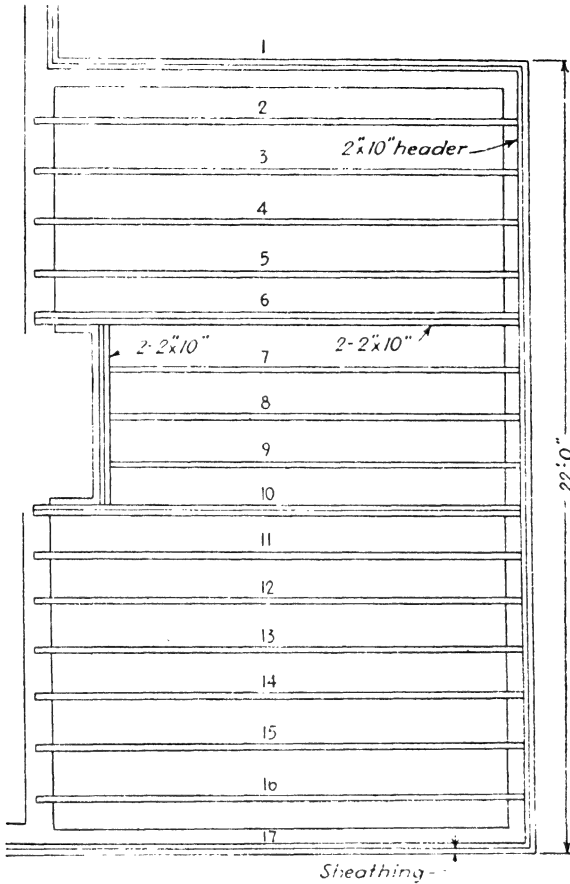


FIG. 106.—Timber connectors.



6. List the floor beams shown on the accompanying sketch, including the headers, and compute the number of board feet, using regular stock lengths.



7. Write at least 500 words of notes on Rough Carpentry, taken from two or three of the books listed in the Preface. Name the books used.

8. State the meaning and use of the following terms, giving sketches where possible: studs, board feet, bridging, corner braces, girder, beam, bridle iron, timber connector, sill anchor bolt, tail brim, header, trimmer, rough carpentry, finish carpentry.

9. Make a complete estimate for the Rough Carpentry required for the house shown in Chap. V. The specifications are stated as follows:

Materials shall be new and thoroughly seasoned and protected from the weather until placed in the building. All lumber shall be dressed on all four sides. Girders shall be dense heart southern yellow pine or Douglas fir. All other framing lumber shall be No. 1 Common Douglas fir. All sheathing and rough flooring shall be tongued-and-grooved No. 2 Common shortleaf pine or fir and shall be not less than  $\frac{3}{4}$ " in actual thickness.

Sills shall be through bolted at corners and at joints, and joints shall be halved together. They shall be anchored with  $\frac{3}{4}$ " bolts and washers to the concrete founda-

tion at corners and at about 12'0" intermediate points and at each side of exterior doors.

Corner posts shall be in one length from sill to plate. Wall and partition studs shall be 2"  $\times$  4", in one length where possible, spaced 16" on centers, spiked to sill and beams and doubled around and trussed over openings.

Beams shall be of the size and spacing noted on the plans and shall be doubled under partitions and around wellholes, and spiked to studs. Ledger board for support of second-floor beams shall be 1"  $\times$  6" and be let into the studs.

Rafter plate shall be two 2"  $\times$  4", breaking joints over supports, lapped at corners and thoroughly spiked.

Partitions sills and plates shall be 2"  $\times$  4", doubled in bearing partitions.

Studs shall be bridged at least once in the height of each story with 2"  $\times$  4". Floor beams shall be cross-bridged with 1"  $\times$  3", not over eight feet apart.

All outside walls shall be sheathed diagonally and all roof horizontally with  $\frac{3}{8}$ "  $\times$  8" T&G lumber, with joints broken over bearings and all driven up tight and nailed with three 8d nails at every bearing.

The entire first and second floor shall have subfloors laid diagonally, with joints broken over bearings, double nailed at every bearing, and shall extend to outside wall sheathing. The attic shall be floored horizontally and extending to outside wall sheathing.

The outside wall sheathing shall be covered with black waterproof building paper, well lapped. Before setting window and outside doorframes, place a strip 8" wide of this paper under the outside casings all around, lapping at least 3" over the outside wall paper.

## CHAPTER XV

### CEMENT WORK

Cement work, sometimes called "cement finish," is frequently included under the Concrete heading. On small jobs it is likely that only one heading, such as Concrete and Cement Work, will serve for all the concrete and cement items on the job. On large jobs a number of headings may be necessary, because entirely different types of concrete construction are involved or because subcontractors are expected to figure certain portions. On very small jobs all the items may be thrown together under the head, Masonwork.

Cement finish is applied as the top-finish wearing surface on floors, usually 1" in thickness. The specifications state the mix desired and the method of treating the top surface. The mix is generally about 1 part cement to between 2 and 3 parts of sand, but special mixtures and special ingredients may also be specified.

The cement base, run along the walls at the floor, comes under this heading. It is generally about 6" high and may be straight or have a cove at the floor. The top may finish flush with the wall surface above or project slightly and have a bullnose edge.

The floor areas are listed in square feet and the base in linear feet. Care must be taken to state the thickness and the mix specified, as well as any special treatment that may be called for. Each thickness and each different kind of work is kept separate, so that proper unit prices may be applied to the quantities.

When subcontract estimates are received for any part of the concrete or cement work, the estimator is required to check them carefully and see that nothing is figured more than once among the several subcontractors whose figures may be used. For example, the subcontractors for the floor and roof construction may include in their figures the floor fill that is placed on top of the floor arches and the fill that is placed on the roof construction for drainage. This fill may be found also in the estimates of the cement-finish subcontractors or on the estimator's own sheets, and an adjustment would therefore have to be made in all the figures for the purpose of making proper comparison among them.

Cement floor finish is applied on top of slabs either immediately following the pouring of the concrete slab, before the concrete has set, or else as a separate coating applied some time afterward. The first method,

which is called "integral" or "monolithic," is the one more commonly used. It consists of a layer of mortar, from a simple sprinkling to a coating 2" thick, which is carefully spread over the base slab. This is then floated smooth with a wood trowel and sometimes also burnished with a steel trowel for a fine finish. The second method, sometimes called "bonded finish," consists of a coating of mortar 1" to 2" thick, applied at a later date to the concrete slab and then finished as above noted or as may be called for in the specifications.

Sometimes no finish at all is applied and the concrete slab is itself finished by floating or troweling. Walks, roads, and other outside pavements of concrete are usually given no special top coating. Interior floors are specified to be treated in one or more of many ways. The estimator must take care to provide for the mixture and the thickness required and also for any hardener or coloring material that is to be incorporated in the finish or applied to it.

Various types of hardeners, waterproofings, and colorings are in use. When these are called for, suitable entries must be made to cover the additional cost of them. The number of square feet of area to be given special treatment is sometimes separately listed and this additional cost is applied to the quantity thus expressed. A better method, however, is to keep each kind of complete floor finish by itself and then price each one with a complete price per square foot. In this way the total cost of each floor area may be readily seen and comparisons and adjustments easily made. This will include all the elements of materials, labor, and incidental expense.

Walks, cellar floors, driveways, and other pavements that are laid directly on earth are customarily included under the heading of cement-finish work. In this kind of work the entire construction of fill, slab, and top finish is figured complete, by the square foot.

The cement treads and platforms that are laid on iron stairs are included in the cement-finish division of the estimate, and these are also measured by the square foot. Light wire mesh is sometimes called for to be embedded in this tread and platform finish, and the unit price is then adjusted so as to include the mesh.

The unit cost of plain cement floor finish runs between 12¢ and 16¢ per square foot. If cinder concrete fill 3" thick is placed under the finish, then 8¢ to 12¢ per foot, additional, must be included, which would make a total of 20¢ to 28¢. This is a typical floor, such as is used in small house cellars or on top of floor arch construction. If, as in a cellar floor, 6" of tamped dry cinders is included as a base under the concrete, a further cost of between 9¢ and 12¢ per square foot is incurred. Thus a pavement composed of a dry cinder bed, a cinder concrete slab, and a top cement finish will cost the contractor about 34¢ per square foot, without

any insurance or general expense items being considered. If broken stone or gravel were used in place of the cinders as the coarse aggregate in the concrete slab, this would increase the cost still further about 5¢ per square foot.

Sills and copings and expansion joints are measured and priced per linear foot, each size and type separately.

**Cement.** Practically all mason supply dealers handle cement. It is packed and shipped in cloth sacks or paper bags. One cubic foot of cement (94 lb.) is contained in each sack or bag. A refund may be obtained for any cloth sacks that are returned in good condition. Paper bags are not returnable. All cement must be kept in a dry place until used.

**Construction.** The general discussion of concrete applies to all concrete and cement work. The term "cement work" is a misnomer anyway, as much of the work included under this heading is really concrete construction, even including, at times, reinforcing mesh or rods.

Concrete is a mixture of cement, water, and inert materials, such as sand, gravel, broken stone, or cinders. After it is mixed and placed, it turns from a plastic mixture into a hard artificial stone, owing to the hydration of the cement. When concrete is properly cured, hardening continues for a long time after it has acquired sufficient strength for the purpose intended. The correct proportions of water, cement, and coarse aggregate to use in the mixture are governed by the character of the work for which the concrete is intended. In a concrete mixture, cement and water form a paste, which, upon hardening, acts as a binder cementing the particles of sand and coarse aggregate together into a permanent mass. The use of too much water thins or dilutes the paste, weakening its cementing qualities. Consequently, to get the best results, it is important that the proper proportions of cement and water shall be used, the exact proportions depending upon the work.

**A workable mixture** of concrete is one of such plasticity and such a degree of wetness that it can be placed readily and that, with spading and tamping, will result in a dense concrete. In a workable mixture there is sufficient cement-sand mortar to give good smooth surfaces free from rough spots, called "honeycombing," and to bind the pieces of coarse aggregate into the mass so that they will not separate out in handling. Mixtures with a deficiency of mortar will be harsh, hard to work with, and difficult to finish. On the other hand, oversanding, or the use of too much sand, increases porosity and reduces the amount of concrete that can be produced with a sack of cement. For given materials and conditions of handling, the strength of concrete is determined solely by the ratio of the volume of mixing water to the volume of cement, as long as the mixture is plastic and workable. The ratio of water to cement also

governs the watertightness or impermeability of the concrete, about six gallons of water per sack of cement usually producing watertight concrete.

Sand or rock screenings, the fine aggregate, includes all particles that will pass through a screen having meshes  $\frac{1}{4}$ " square. Coarse aggregates range from  $\frac{1}{4}$ " up to  $1\frac{1}{2}$ " or 2". In thin slabs or walls the largest pieces of aggregate should not exceed one-third the thickness of the section of concrete being placed.

Concrete should be placed as soon as it is ready, in no case more than 45 minutes after mixing. It should be deposited in layers of uniform depth, usually not exceeding 6" in depth. It should be continually tamped or spaded so that it will settle thoroughly and produce a dense mass.

**The surface finish** of a floor or walk should be obtained by using a wood float. A metal trowel should be used sparingly, if at all, because its use brings to the surface a film of fine material that lacks the wearing quality of the cement and sand combined and may cause the surface to develop hair cracks after the concrete hardens. Although a troweled surface is smoother, it does not wear so well as a floated surface and is likely to be slippery.

If concrete is left exposed to sun and wind before it has properly hardened, much of the water necessary to hardening will evaporate and the concrete will simply dry out. Moisture is needed for the proper hardening of concrete because, as has already been mentioned, this process is due to changes that take place in the cement when it is mixed with the proper amount of water. Concrete floors, walks, pavements, and similar large surfaces can be protected by covering them with sand, moist earth, or some other moisture-retaining material as soon as the concrete has hardened sufficiently to permit doing so without marring the surface. In warm weather this covering should be kept moist by frequent sprinkling for a period of about 10 days. Walls and other sections that cannot be covered in this manner can be protected by hanging moist canvas or burlap over them. During colder weather, protection is equally important, but the concrete need not be kept moist, as evaporation is not so rapid.

**Basement floors** in houses are generally 4" thick and are preferably laid in one course directly on the ground or on suitable fill. The floor is laid off in strips 4 or 5 feet wide extending the full length or width of the basement. For forms,  $2 \times 4$ s are set on edge and so positioned that they provide grounds or guides for the strike board used in leveling off the surface. Stakes are driven along the  $2 \times 4$ s to hold them in place. After the concrete has been placed and leveled off with the strike board, the surface is floated to fill in low places and work down high spots. If the floor is to be pitched toward a drain, this should be provided for in setting the  $2 \times 4$ s. After the surface is evened off, the concrete is allowed to

stiffen until it is ready for the final troweling. Too much troweling is not advisable.

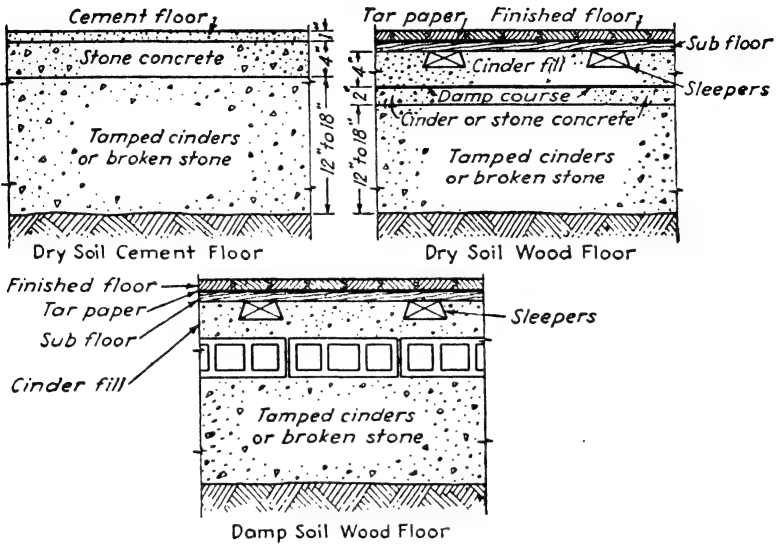


FIG. 108.—Floors on earth.

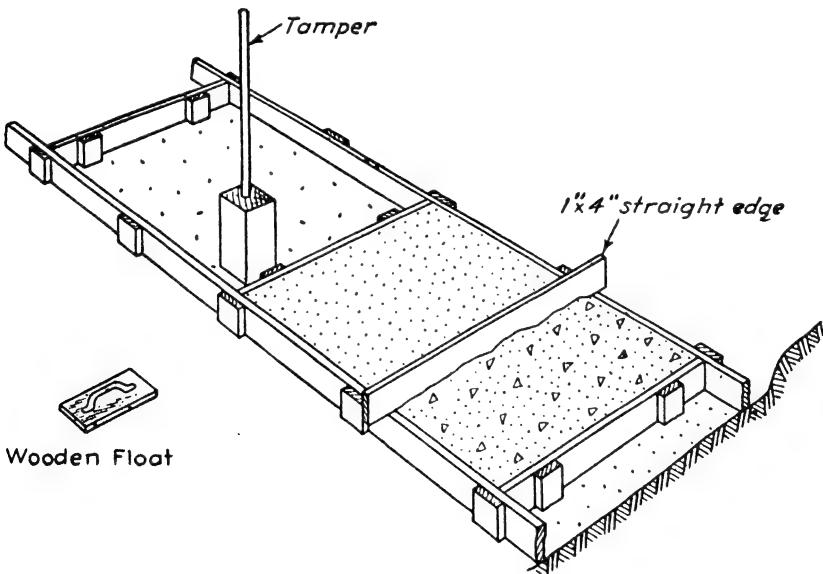


FIG. 109.—Sidewalk construction.

**Sidewalks** should always rest on a firm base. If the soil on which they are to be laid is well drained, the concrete can be placed directly on it after all refuse, grass, roots, and similar materials have been removed and

the ground has been well compacted. If the soil is not well drained, a six-inch subbase of well-compacted, clean, coarse gravel or clean cinders should be provided. Sidewalks are generally built by the one-course method, as described for basement floors above, and the surface should be sloped slightly toward one side, to make sure that rain water will drain off. For convenience in building and provision for expansion and contraction joints, walks should be divided at 4- to 6-foot intervals with partition strips placed at right angles to the side forms. Every other section is then concreted. After these have hardened, the cross strips are removed and the remaining slabs are placed.

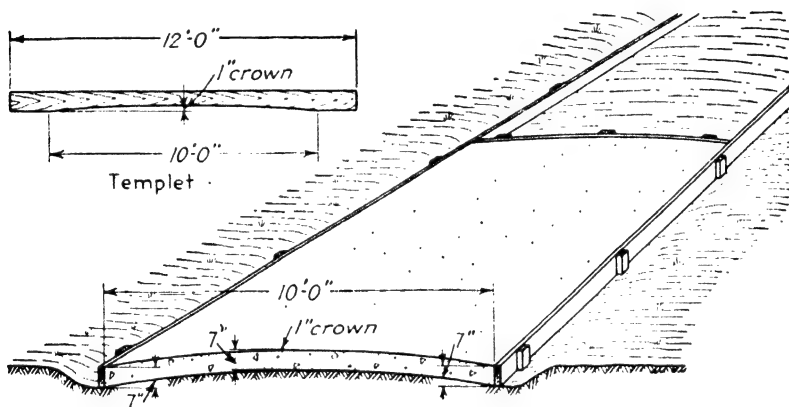


FIG. 110. Concrete driveway.

**Driveways and curbs** are sometimes included with building work and are listed under Cement Work. Driveways are made not less than 7"

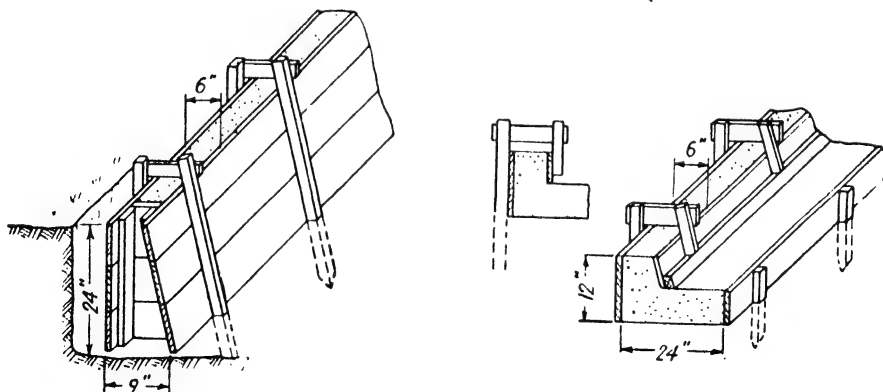


FIG. 111.—Curbs.

thick, in order to carry the load of moving vehicles. The center of the driveway is given a crown of about 1", to ensure rapid drainage. This

crown is produced by means of a curved strike board or template, which shapes the surface. The area on which the pavement is to be placed should be brought to the required grade, with such excavation and filling as may be necessary to secure the required uniform slope. All filled-in places should be thoroughly tamped, and the ground should be shaped,

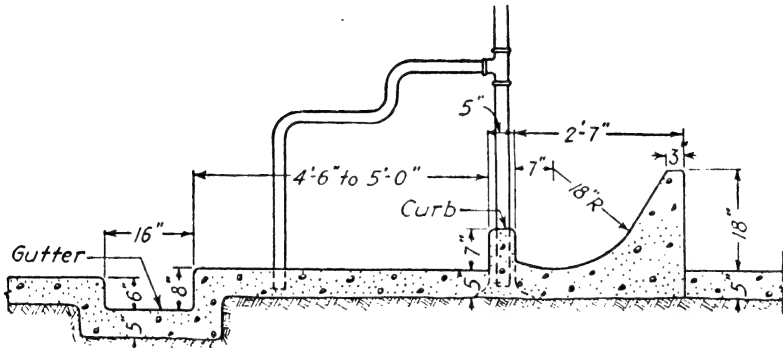


FIG. 112.—Cow stall.

with the center 1" higher than the outer edges, so that the finished pavement will have a uniform thickness. Side forms of  $2 \times 6$ s or  $2 \times 8$ s should be set, with their tops at the right level to serve as guides for the templates. The finishing is done with wood floats attached to long handles. Pavements should be protected from the drying action of the sun and the wind by being covered and kept moist for at least two weeks before the driveway is used.

Curbs and similar construction require special formwork, and on large jobs of curbs steel forms are recommended.

**Concrete steps** are safe, nonslippery, and so durable as to last indefinitely if they are properly constructed. Stairways and long flights of steps are generally listed under the heading, Concrete Work, but small sets of steps are always placed under Cement Work.

When steps are built between side walls, the walls are completed first. When these forms have been removed, the space that will be under the steps is filled in with earth and thoroughly tamped, to provide a firm base on which to pour the concrete for the steps. Steps of this kind resting on well-compacted earth require no reinforcement.

Planks for supporting the riser forms are held firmly in place against the walls by means of cross braces, and pieces of  $1 \times 4$  or  $2 \times 4$  are nailed to the planks for holding the riser forms in place. For a comfortable flight of steps the vertical distance from one step to the next should not exceed  $7\frac{1}{2}$ " and the width of the tread should be at least 10".

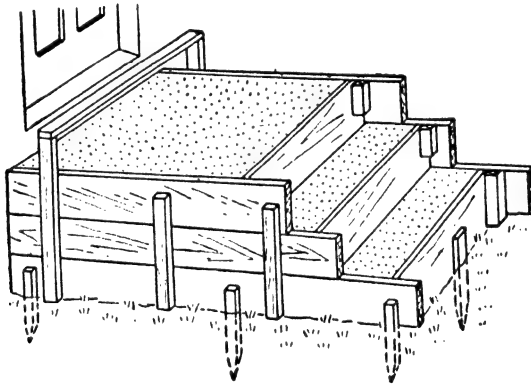
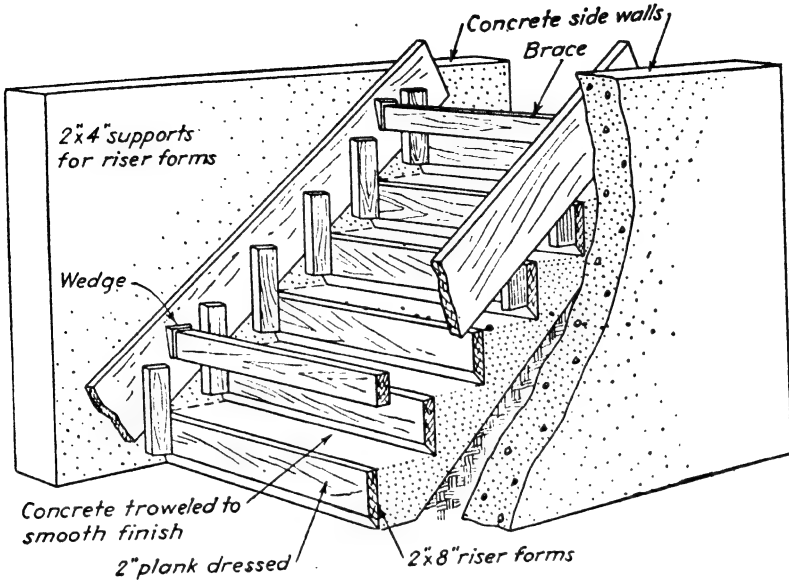


FIG. 113.—Concrete steps.

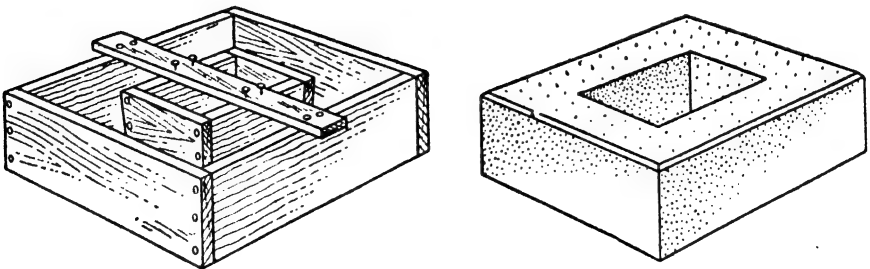


FIG. 114.—Chimney cap and form.

**Chimney caps** are either cast in moulds, on the ground, and then placed on top of the chimneys, or are cast in place by building forms on the chimney tops. The inner core of the chimney form, which has beveled sides to facilitate removal, is held in place by a strip nailed across the top of both forms.

### Exercises

1. Make a sketch of a typical basement floor, in cross section, showing a bed of cinders, with a monolithic-finished concrete slab on top. Mark the thickness of each.

2. Write at least 200 words of notes on cement work, taken from one or two of the books listed in the Preface. Name the books used.

3. Make a complete estimate of the cement work required by the house plans shown in Chap. V. The specifications are stated as follows:

Cement shall be fresh Portland cement. Sand shall be clean, coarse, and sharp. All coarse aggregate shall be either crushed rock or gravel, ranging in size from  $\frac{1}{4}$ " to  $1\frac{1}{2}$ " and shall be free from dirt.

All concrete shall be composed of 1 part cement, 3 parts sand, 5 parts coarse aggregate, and  $\frac{1}{10}$  part hydrated lime. The floor of the basement shall have a 1" finish coat, consisting of 1 part cement, 2 parts sand, 4 parts crushed rock (pea size), applied immediately after the base slab is laid and before it has taken initial set, floated and troweled to a hard smooth finish.

Lay a 3" concrete bed in the bathroom floor, ready to receive tile by others.

Form a cement wash, 1" thick at the outer edges and sloping up to 3" thick, on top of the chimney brickwork.

Construct the walks, service platform, and driveway strips of a 9" bed of coarse gravel or broken stone, with a 4" concrete top, wood-floated to a smooth, uniform finish. Install  $\frac{1}{2}$ "  $\times$  6" composition expansion joints approximately 4'0" apart and at the garage apron and front sidewalk.

Construct the garage floor and ramp and the strip of concrete forming the ramp at street curb similar to the walks and driveway strips but with concrete slabs 6" thick. The curb is already cut and ready for the driveway ramp.

Protect all concrete surfaces by covering with burlap and keep this protection moist for ten days.

## CHAPTER XVI

### PLASTERING

The heading for the plastering division is sometimes given as Lathing and Plastering. It usually includes all the work done by the lathers and the plasterers.

Plaster is applied directly to brickwork, terra cotta blocks, gypsum blocks, and other masonry and on wood or metal lath and plasterboards. Stucco, which is just exterior plastering, is included under this heading. Metal corner beads and the iron hangers installed by metal lathers in suspended ceiling construction also come under this heading.

Grounds are wooden strips made to a uniform thickness, which are applied by the carpenters and belong under the heading, Carpentry. They are installed to act as guides for the surface of the plaster. They serve as stops against which the plaster is finished and also provide a means of fastening the trim to the walls. Grounds of  $\frac{7}{8}$ " thickness are required when three-coat plastering on wood lath is to be used; grounds  $\frac{3}{4}$ " thick are required for three-coat work on metal lath; grounds  $\frac{5}{8}$ " thick are required for two-coat work on masonry.

Plasterboard work is put under this heading, especially when it is to be coated with plaster. If the boards are simply nailed on, the work is sometimes put under the carpentry heading. Each board contains eight square feet. The boards are  $32'' \times 36''$  and therefore suitable for  $12''$ ,  $16''$ , or  $18''$  nailing on wood studs, etc. Thicknesses obtainable are  $\frac{1}{4}''$ ,  $\frac{3}{8}''$ , and  $\frac{1}{2}''$ .

Wood laths are  $\frac{1}{4}'' \times 1\frac{1}{2}'' \times 48''$ , which allows for  $12''$  and  $16''$  nailing. They are applied  $\frac{1}{4}''$  to  $\frac{3}{8}''$  apart. Metal lath comes in many forms of expanded metal sheet and woven wire mesh.

There are many kinds of plaster and stucco materials and finishes. Prepared plasters, already mixed or partly mixed, are in use now to a large extent.

The work included under this heading is measured by the square yard for flat surfaces and by the linear foot for mouldings, cornices, corner beads, etc. Some estimators make no deductions for the openings. Some take half of these "outs." Still others take no "outs" of less than 21 square feet and, therefore, would measure an average wall or partition as though it had no windows or doors. Although the last of these methods seems to be the one most commonly used, it is best to state at

the very beginning of the plastering estimate which method is being used. In this way anybody reading the estimate will note the method adopted and disputes on this will be avoided. Similarly, in bids and letters in which the method of measuring is concerned it is a wise precaution to state which method is assumed.

Care must be taken in listing the work to see that all the items are included. Not only are room walls and ceilings plastered but also walls and ceilings in passageways, halls, storage rooms, bulkheads, etc. Soffits of stairs, landings, mezzanine platforms and showrooms often have work under this heading. In addition to the lathing and plastering, there are items of corner beads, arches, and outside plastering, or stucco, to be considered.

The student should not become too much bound by definite rules of procedure in estimating any trade. All the work should be written up, however, so that a complete story is made in the estimate of the proposed building. The test of a good estimate is the ease with which another estimator can understand every item. With plastering work, care should be taken to separate the listing of the quantities into many parts, depending on the location in the building, the kind of plastering, the number of coats involved, the kind of lathing, etc. In this way the estimate may readily be checked or adjusted and what is more important—it may be priced at proper cost prices to suit each individual item or group of items.

It is recommended that the work for each floor be kept separate from that of other floors. In this way, one large error—that of omitting an entire floor—is less likely to be made. Concentrating thus on one floor, the estimator of little experience will find it easier to visualize the work shown on the plans.

An illustration of a portion of an estimate in plastering is given in Fig. 115. Note the general form of layout and the systematic arrangement of the names of minor headings and the figures. The totals are extended for the quantities and suitable prices are applied.

**Plastering Costs.** Plain plastering costs the contractor 80¢ to \$1.00 per square yard for two-coat work on masonry. Three-coat work on lath, including the cost of the lathing, runs from \$1.50 to \$2.00 per square yard. Hung ceilings, formed of iron hangers, runners, metal lath, and three coats of plaster, cost between \$2.50 and \$3.50 per square yard. Plain cornices run from 50¢ to \$1.00 per linear foot. Corner beads cost 12¢ to 15¢ per linear foot.

**Lathing.** Wood lath must be solidly nailed at every bearing. Ceiling lath must run in one direction only. Joints in all wood lathing are broken at least every eighth lath. Wood lath, mostly of spruce, is  $\frac{1}{4}$ " thick and 32" or 48" long, and  $1\frac{1}{2}$ " wide.

Metal lath is made of stamped metal or wire mesh. The stamped or expanded metal lath comes in sheets 24" wide and 8'0" long. Wire mesh

| PLASTERING                           |         |  |  |          |  |          |  |     |  |
|--------------------------------------|---------|--|--|----------|--|----------|--|-----|--|
| (FULL OUTS TAKEN)                    |         |  |  |          |  |          |  |     |  |
| BASEMENT                             |         |  |  |          |  |          |  |     |  |
| Stair walls, on T.C. blks.           |         |  |  |          |  |          |  |     |  |
| 2 x 25'-0" x 12'-0"                  |         |  |  | 600      |  |          |  |     |  |
| OUTS 2 x 3-0 x 7-0                   |         |  |  | - 42     |  |          |  |     |  |
|                                      |         |  |  | 9 ) 558  |  |          |  |     |  |
|                                      |         |  |  | 62 yds   |  | 1.10     |  | 68  |  |
| FIRST FLOOR                          |         |  |  |          |  |          |  |     |  |
| Corridor walls, on T.C. & Gyp. blks. |         |  |  |          |  |          |  |     |  |
| N.                                   | 100'-0" |  |  |          |  |          |  |     |  |
| E.                                   | 155-4   |  |  |          |  |          |  |     |  |
| S.                                   | 101-4   |  |  |          |  |          |  |     |  |
| W.                                   | 122-0   |  |  |          |  |          |  |     |  |
| 478-8 x 14-0                         |         |  |  | 6701     |  |          |  |     |  |
| OUTS                                 |         |  |  |          |  |          |  |     |  |
| 6 x 6-0 x 8-0 288                    |         |  |  |          |  |          |  |     |  |
| 24 x 3-0 x 7-0 504                   |         |  |  | - 792    |  |          |  |     |  |
| 792                                  |         |  |  | 9 ) 5909 |  |          |  |     |  |
|                                      |         |  |  | 655 yds  |  | .95      |  | 622 |  |
| Show room walls, on Gyp. blks.       |         |  |  |          |  |          |  |     |  |
| 84-0                                 |         |  |  |          |  |          |  |     |  |
| 55-0                                 |         |  |  |          |  |          |  |     |  |
| 117-6                                |         |  |  |          |  |          |  |     |  |
| 97-6                                 |         |  |  |          |  |          |  |     |  |
| 354-0 x 14-0                         |         |  |  | 4956     |  |          |  |     |  |
| OUTS                                 |         |  |  |          |  |          |  |     |  |
| 3 x 6-0 x 8-0 144                    |         |  |  |          |  |          |  |     |  |
| 22 x 3-0 x 7-0 462                   |         |  |  | - 702    |  |          |  |     |  |
| 1 x 12-0 x 8-0 96                    |         |  |  | 702      |  | 9 ) 4254 |  |     |  |
|                                      |         |  |  | 473 yds  |  | .95      |  | 449 |  |
| FWD. 1139                            |         |  |  |          |  |          |  |     |  |

should be extended at least 3" on the surface of the walls and be securely fastened.

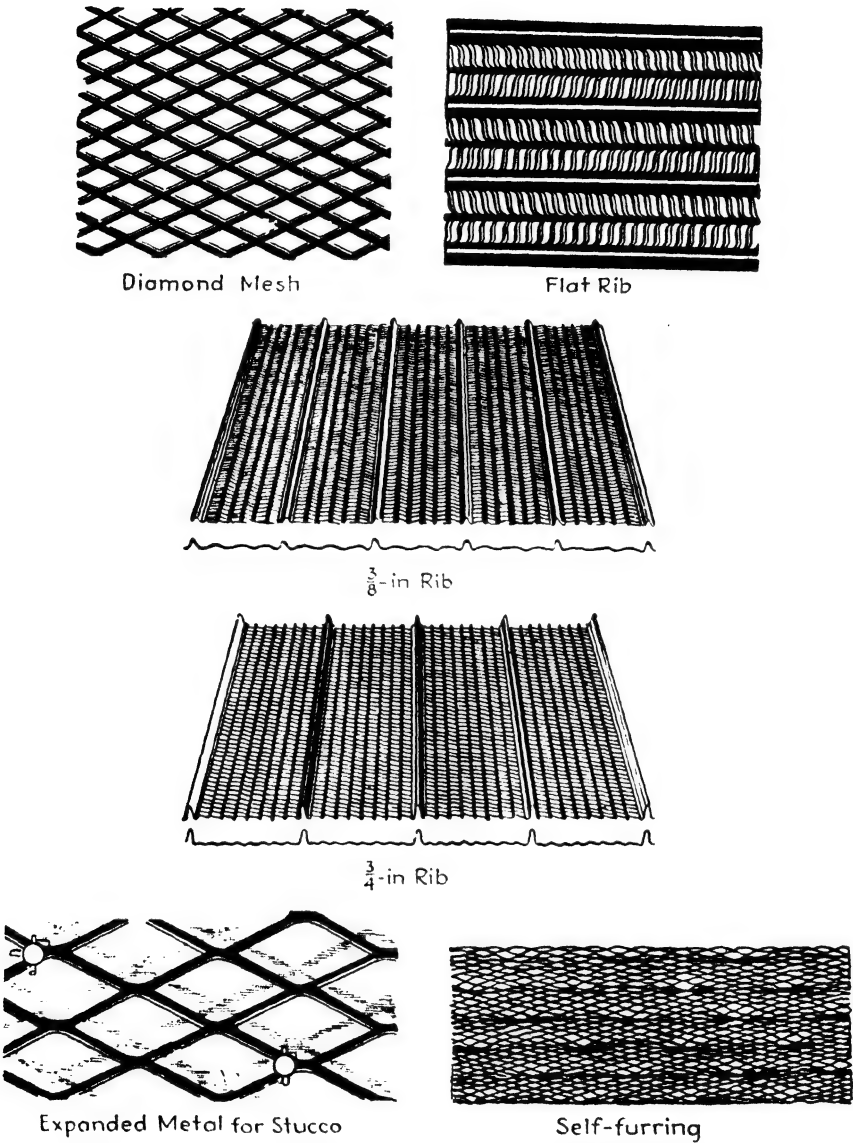


FIG. 116.—Types of metal lath.

Suspended ceilings are formed of iron or wood hangers and runners on which the lath and plaster are applied. Iron hangers and runners are used in fireproof construction. The whole ceiling construction is meas-

ured and priced per square yard of plastered surface. Hangers for suspended ceilings must be placed in line in either direction and with maximum spacing of 5'0" on centers. With floor arch construction, the hangers extend through the arches and are formed of two pieces of 1" channels or  $\frac{3}{16}$ "  $\times$  1" flat bars, at least 7" long, and bolted, riveted, or welded together to form a tee. Purlins of 1½" channels or angles are bolted to each hanger, with a maximum spacing of 5'0". Cross furring consists of at least 1" channels, wired on, with a maximum spacing of 12".

Metal corner beads are used on vertical external corners, and sometimes strips of metal lath are applied on internal corners.

**Plastering.** Plaster is classified as lime plaster, gypsum plaster, or cement plaster, depending upon which of these materials is used in it. Cement plaster is used especially in places where more resistance to fire is desired or in damp places, such as cellars. Gypsum plaster is always used on gypsum blocks and on plasterboards. Any plaster may be used on wood or metal lath.

The first coat of plaster applied to lath is called the "scratch" coat. It consists of lime, sand, and hair and is forced into the lath so that some of the material comes through it to form a key. Before this coat hardens, it is scratched with a scratching tool or with a piece of metal lath, to produce a rough surface for holding the next coat.

The second coat is called the "brown" coat. It is formed of lime and sand only and is applied as the thickest of the three coats and brought to a true surface with a wood trowel, called a "float."

The third coat is called the "white" coat or "finish" coat. It is made of lime and plaster of Paris and is only about ⅛" thick. It is usually troweled with a steel trowel to a hard, smooth finish, ready to be painted or covered with wallpaper. The plaster of Paris gives it the hard, smooth finish. Keene's cement, a very finely ground cement, also is used occasionally for the finishing coat.

Ready-mixed materials, some complete and ready for mixing with water only, and others, which require the addition of sand, are obtainable in 50 and 100 lb. bags. These ready-mixed materials are commonly used in place of plaster mixed at the job, of the original ingredients.

Stucco, or exterior plasterwork, is generally formed of three coats of cement mortar. Various surface finishes are given by varying the method of floating or troweling employed or by incorporating pebbles or other materials in the finish coat. Ready-mixed stuccoes, some colored, are also obtainable.

Other kinds of plaster, including decorative or colored finishes, are used at times, in addition to the common type of work described above. In any event, the work is measured in square yards of completed surface and the price per yard is applied that will take care of the cost of the

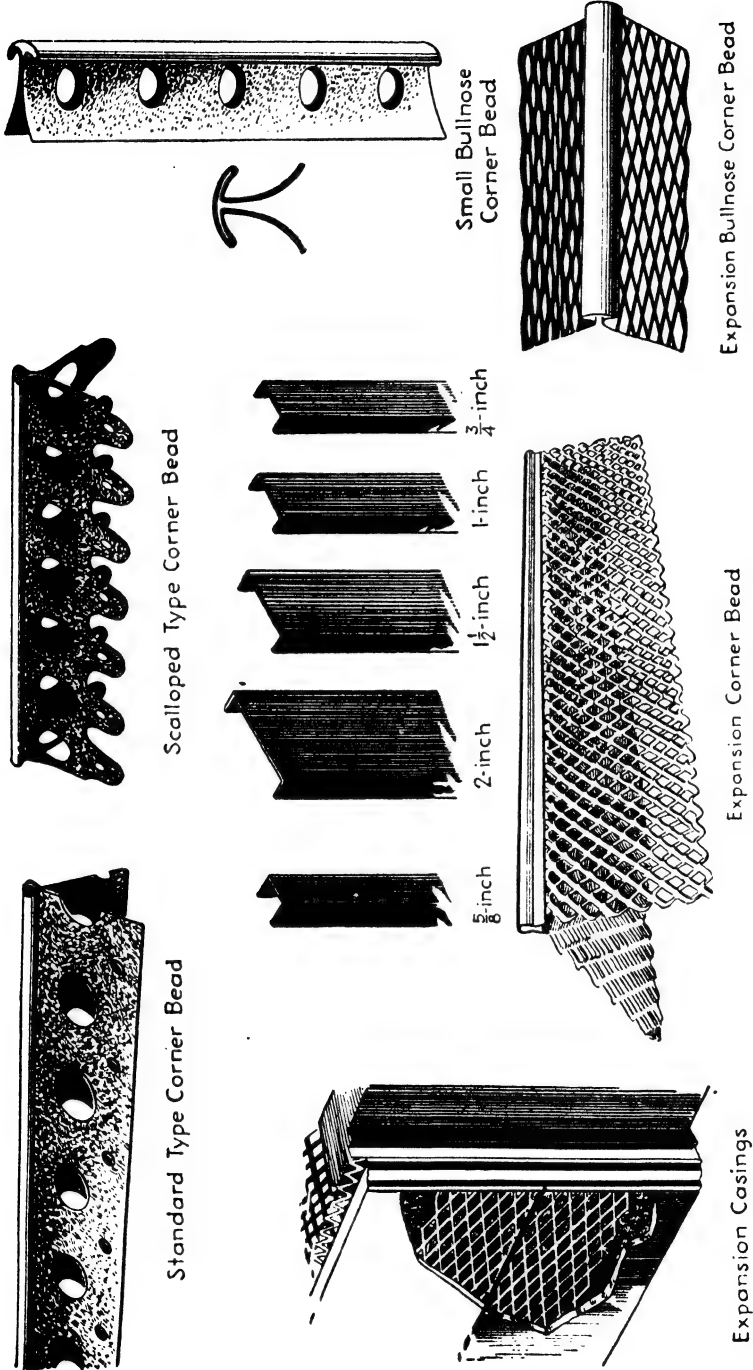


FIG. 117.—Corner beads and channels.

entire plaster-work and include the cost of the lathing or other plaster base that may be called for.

Plasterboards are usually estimated under this heading or under the heading, *Rough Carpentry*. Two coats of plaster or just one heavy white coat is usually applied to the plaster boards. If no plaster is to be applied to them, the painters are sometimes called upon to fill the joints before painting. They use a putty knife for filling the joints with spaechel or some other plaster mixture, in order to comply with the union agreements, which prevent them from using trowels such as the plasterers would use. Plaster-boards come in several thicknesses and sizes as has been noted before, some with prefinished surfaces.

### Exercises

1. Make a sketch plan of a plastered bedroom and closet, showing dimensions, and then prepare a quantity survey of all the plastering work involved.

2. Why are such strong members and such careful methods required by building codes in suspended ceiling construction?

3. Write at least 300 words of notes on lathing and plastering from one or two of the books listed in the Preface. Name the books used.

4. Make a complete estimate of the plastering work for the house. The specifications are as follows:

Apply expanded metal lath, weighing at least 3# per square yard, to all wall and ceiling surfaces in the garage, bathroom, toilet, kitchen, and rear entry, and also on the walls and stair soffit in the cellar stairway.

Apply good, sound spruce lath, secured with galvanized nails, on the walls and ceilings in all the other rooms, closets, and halls. Install strips of expanded metal lath, over the wood lath, in all vertical and horizontal internal corners and extending at least 3" on each of the surfaces.

Install galvanized No. 20 gauge metal corner beads on all external plastered corners throughout, extending the full height of the plaster.

Apply three coats of cement mortar in the garage, brought to a smooth, troweled finish. Apply a scratch coat of cement for the tilework in the bathroom and the toilet.

Apply three coats of lime plaster, with Keene's cement incorporated in the finish coat, in the bathroom, toilet, kitchen, rear entry, and cellar stairway.

Apply three coats of lime plaster on all the wood lathing, brought to a perfect, hard, white, troweled surface.

## CHAPTER XVII

### FINISH CARPENTRY

Finish carpentry includes all the items of carpentry except what is required for concrete forms and rough-framing work. The formwork is always included under the concrete headings. The rough framing, rough flooring, wall and roof sheathing, and other items of carpentry that are put in place before the lathing is started, are put under the heading, Rough Carpentry. On very small jobs, however, all of the carpentry may be included under a single heading. On very large jobs it is usually advisable to set up separate headings for the special items, such as stair work, finish flooring, kalamein work, overhead-type doors, etc. The estimator uses his own judgment about arranging his estimate. The main thing is to see that every item is properly estimated under some suitable heading and that nothing is estimated more than once.

**Millwork.** Most contractors take estimates from millwork manufacturers for furnishing all the millwork required for a job. Then they either add a certain percentage of the material figure, to cover the labor, or list the items and price them at prices to suit each one. Others list all the items in detail, just as the millwork dealer would do, and then send copies of their list to several dealers for prices.

It is dangerous to use the percentage method of pricing the labor unless the work is of a type that can be judged accurately. The labor cost, not including insurance or general expense, runs usually between 90% and 120% of the material cost, for ordinary work.

It is a good idea to make small sketches of each piece of millwork listed, especially those that cannot be described in a few words. A sketch often gives more information than even a lengthy description. The sizes of the various members shown in each sketch should, of course, be given in the sketch if they are not listed clearly.

In listing windows, care must be taken to state that the dimensions are sash sizes or mason-opening sizes. Sash sizes are usually given for windows in frame buildings and mason-opening sizes for windows in masonry buildings.

The thickness of doors and of window sash makes a decided difference in the cost, both for the material and for the labor of installing. The two most common thicknesses are  $1\frac{3}{8}$ " and  $1\frac{3}{4}$ ". Sizes of doors and windows are always given by stating the width first, then the height, and finally the

thickness. Thus, a door might be  $2'10'' \times 6'8'' \times 1\frac{3}{8}''$ , and a window might be  $2'9'' \times 5'2'' \times 1\frac{3}{4}''$ . Note that the thickness of a door refers to the thickness of the stiles and rails and not of the panels, and the thickness of a window means the thickness of the sash and not of the frame. All other essential information should, of course, be given, besides.

Wood doors are made in many stock sizes and stock patterns. White-pine doors are generally used for exterior openings. White pine, fir, and birch are commonly used for interior doors, sometimes one material being used for the stiles and rails and another for the panels. The common thickness for exterior doors is  $1\frac{3}{4}''$ , and the thickness most used for interior doors is  $1\frac{3}{8}''$ . These, as has been noted, are the thicknesses of the stiles and rails. Unless raised panels are called for, the panels are usually very thin. Cupboard doors are only about 1" thick.

A single door consists of one leaf. Double doors, or pairs of doors, have two leaves. Double-acting doors are those that swing into both rooms on double-acting hinges.

Overhead doors, which swing up above the door opening, are provided with special fittings and hardware for this purpose.

Sliding doors slide sidewise or vertically and are provided with special tracks, rollers, guides, etc.

Fireproof doors may be of kalamein, hollow metal, or all steel. Kalamein doors are those made of wood and covered over with metal.

Figure 118 shows vertical sections through a typical interior door opening. These illustrate the construction of a well-made door. A rabbeted solid frame, rough buck, grounds, two types of trim, and a backband are also shown.

Figure 119 shows horizontal sections through two types of doors, one with a solid rabbeted frame and the other with jambs and stops.

Figure 120 shows the designation of doors as to the swing. These designations are used also in describing the hardware requirements.

Figures 121 to 124 show various window details. They will also serve to illustrate the entire construction around window openings in both masonry and frame buildings. The student should go over all of these carefully, noting every member and its relation to all the other members.

Exterior trim for water tables, eaves, etc., is carefully listed and priced to suit the work called for on the plans or in the specifications. Simple items may be merely named and the size and number of linear feet be given; but elaborate cornices, etc., will require sketches and description.

Interior trim, such as baseboards, chair rails, wall mouldings, and plain handrails, can generally be listed by stating the number of linear feet required and the sizes. Careful measurements should be taken of

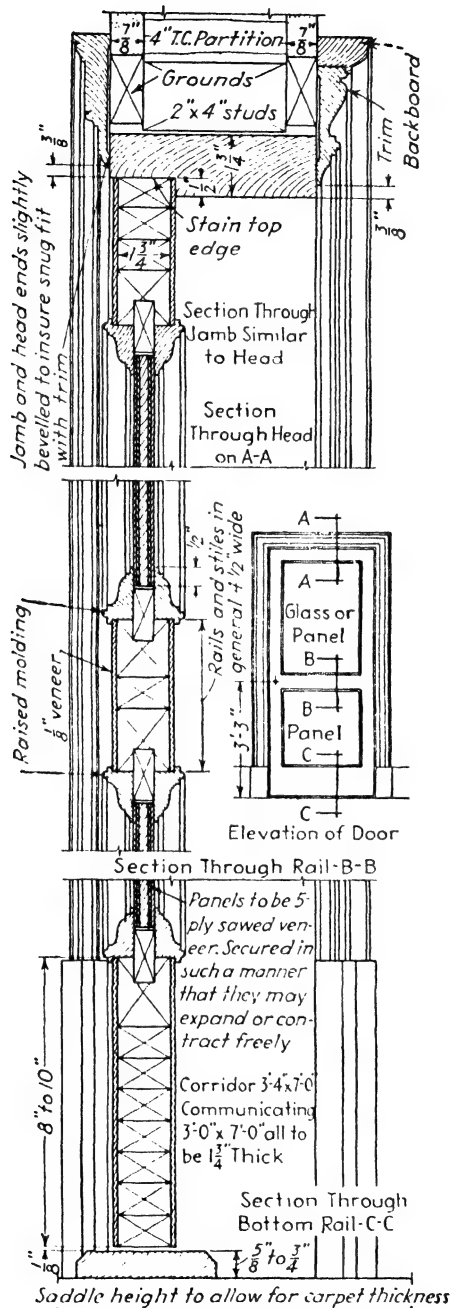
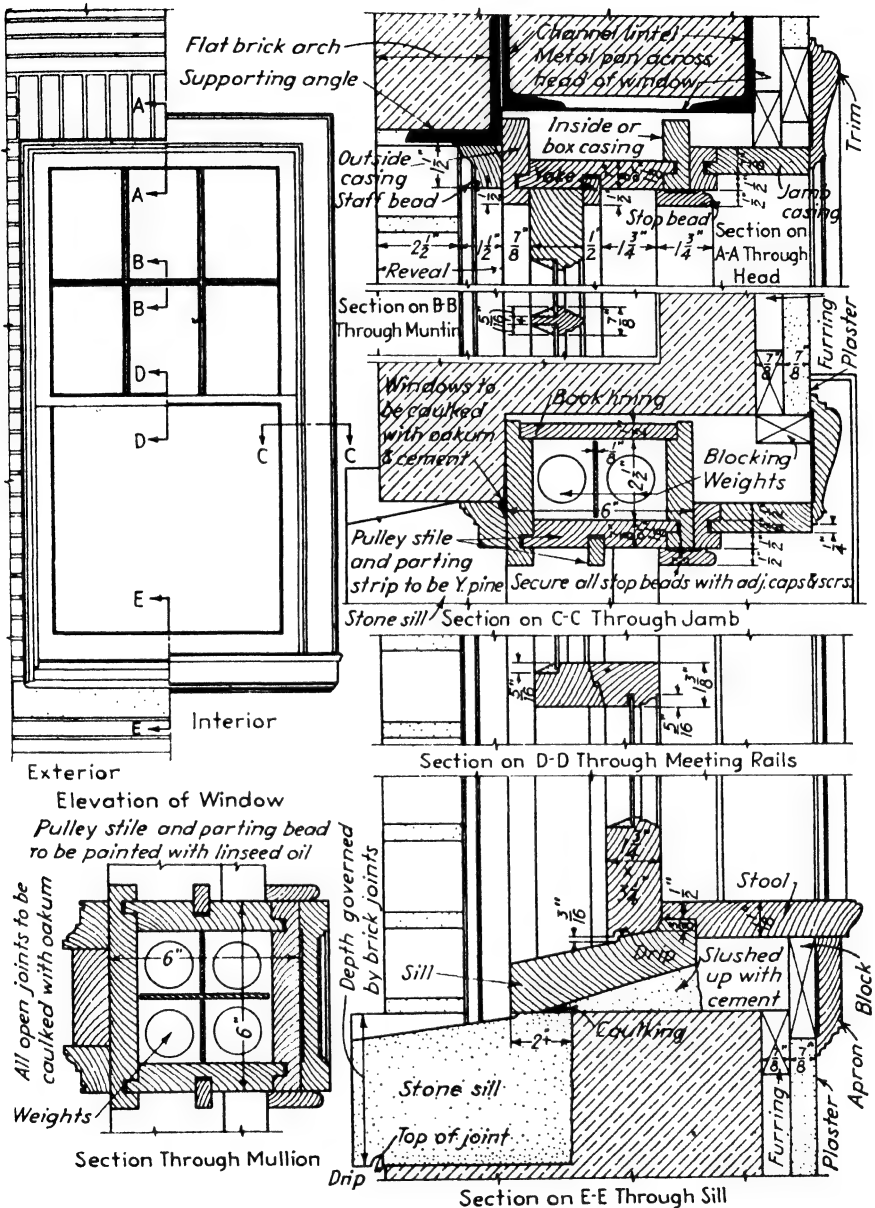


FIG. 118.—Vertical section through door.





these items, as well as those of more elaborate nature, with particular care that all the items are included and all the rooms are taken into account.

The trim for doors and windows is often included with the pricing of the doors and windows. If not, these items must be listed and priced



Handrails, while they may be priced per linear foot for straight work or for straight portions, also require pricing by the piece for any ease-

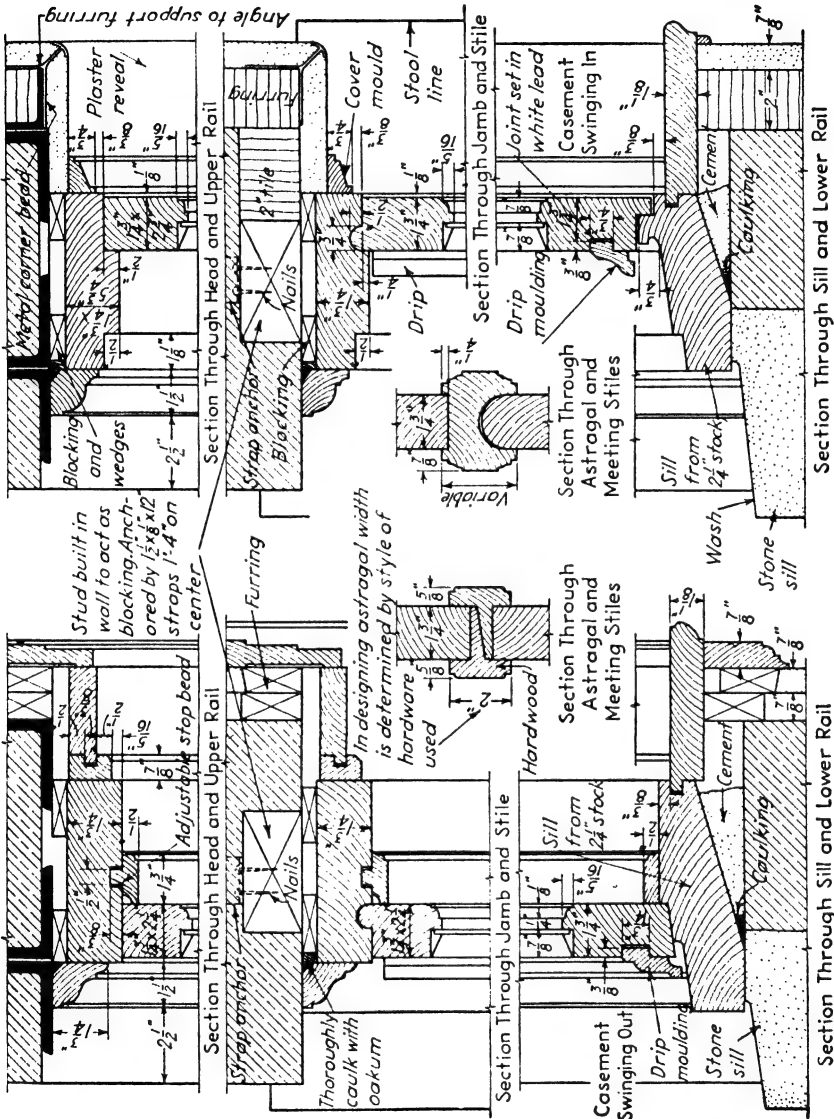


FIG. 123. -Casement windows in masonry.

ments, twists, etc., in addition, and pricing per piece for handrail brackets that may be required. Easements and twists may cost \$5 to \$20 each.

Figure 125 shows details of exterior cornices on masonry and frame buildings. While these are more elaborate than those found on ordinary buildings, they will serve to illustrate many features of construction with

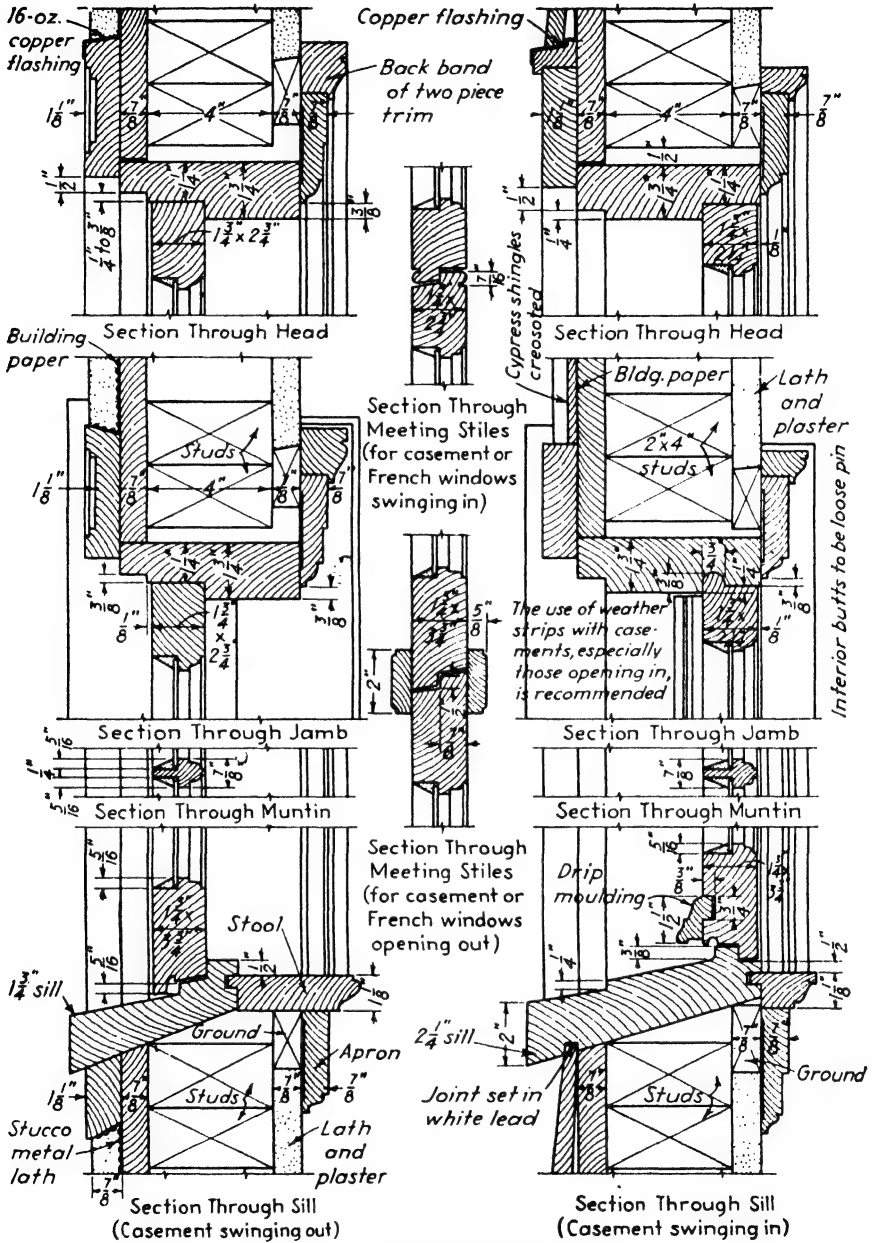


FIG. 124.—Casement windows in frame.

which the estimator should be familiar. Go over these details, item by item. Note the work involved in putting the various parts together.

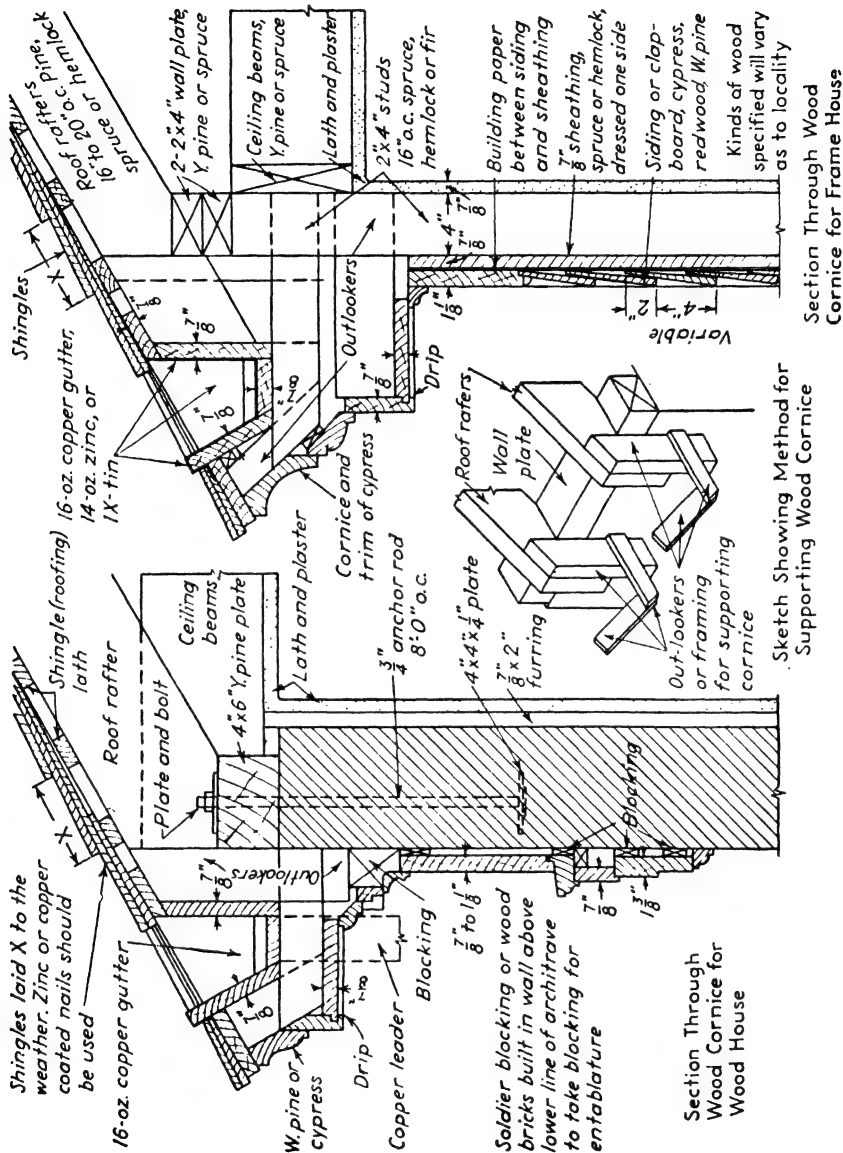


Fig. 125. -- Wooden cornices.

**Note the amount of blocking required for work of this character. Realize the substantial scaffolds that must be provided for doing the work safely.**

Figure 126 shows the construction of a typical porch of the sun-room type. Note here the great amount of blocking and the large number of

members required. The hardware alone for a porch with many doors and windows, such as this one, is an item of considerable expense to be estimated, especially if it is to be of solid bronze, as it should be.

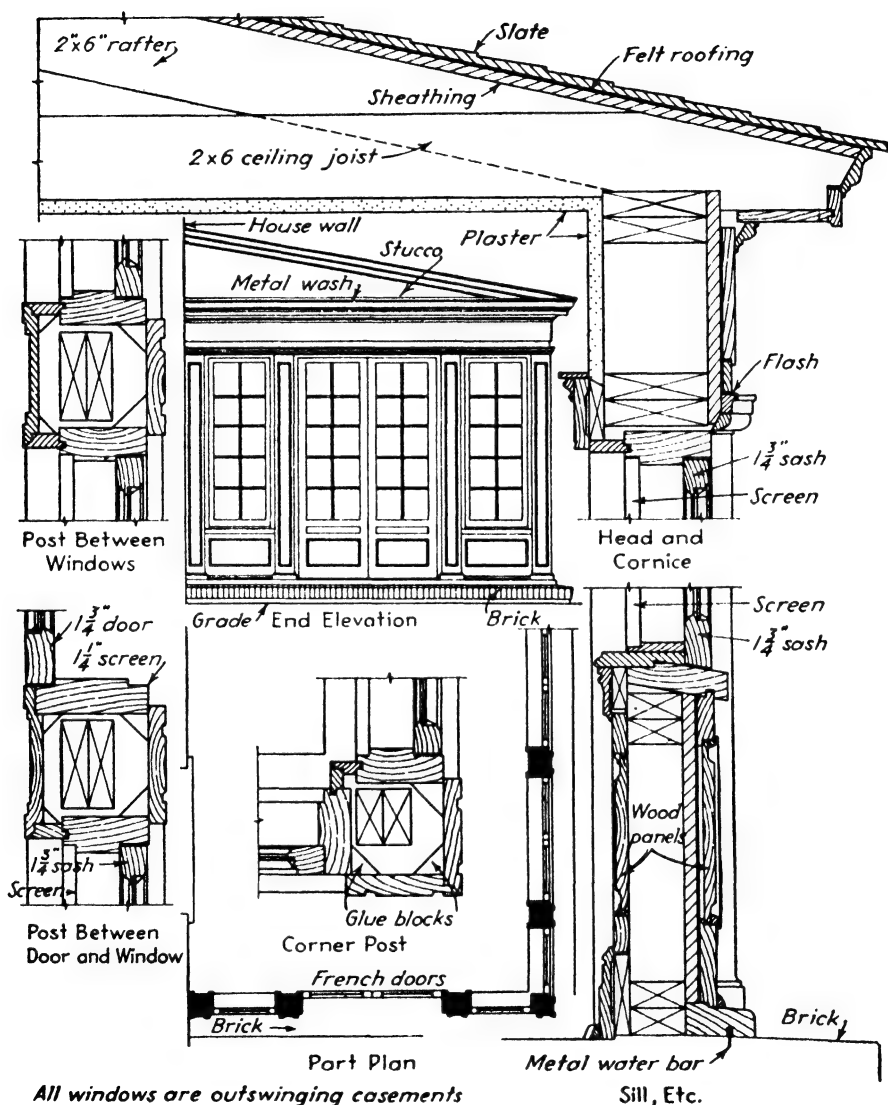
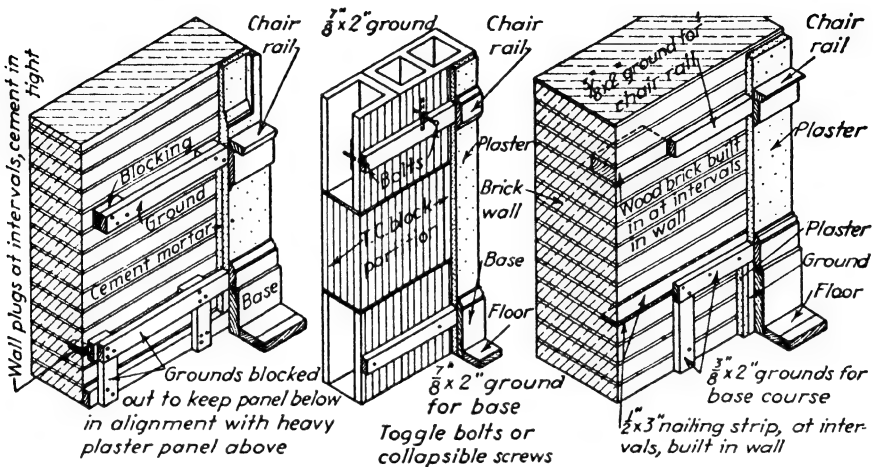


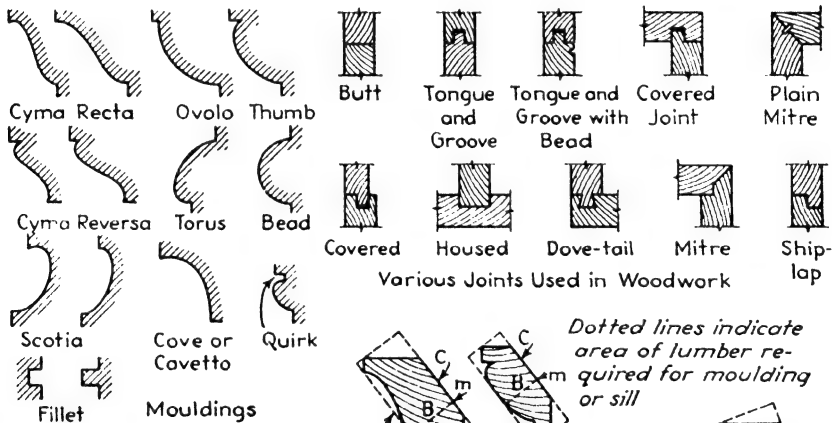
FIG. 126.—A sun porch.

Figure 127 shows various items of interior trim and some of the blocking that must be considered in connection with it, if the blocking is not provided for under the heading, *Rough Carpentry*.

**Flooring.** Wood flooring is generally  $2\frac{5}{32}$ " thick and is tongued and grooved, or "matched." The most common face widths are  $2\frac{1}{4}$ " and



Fastening of Grounds, Blocking and Nailing Strips in Masonry Construction



Draw line A through the two highest projecting points on sill or moulding. Line B is then drawn  $\perp$  to line A. On this line B lay off thickness of lumber required as point m. Through point m, draw line C  $\parallel$  to line A. Length of line A and C depend on design of sill or moulding to be used.

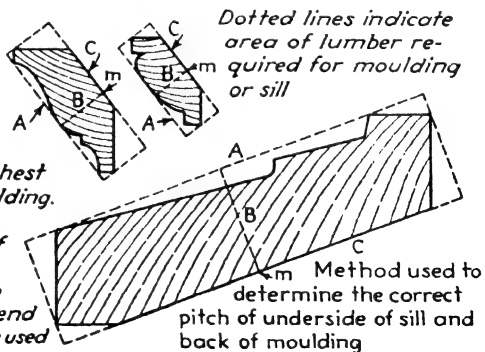


FIG. 127.—Grounds, joinery, and moldings.

$3\frac{1}{4}$ ". These widths are made from 3" and 4" wide stock, respectively, and are figured on the basis of 3" and 4" widths. As several grades of

flooring are made in each kind, the estimator must be careful to price the work to suit the grade specified.

Oak flooring is classified first as White or Red Oak. It is further classified as Plain-sawed or Quarter-sawed. Still further it is graded as Clear, Select, No. 1 or No. 2, if it is plain sawed material, or as Clear, Sap Clear or Select, if it is quartersawed. Maple flooring is classified as White Clear, Red Clear, First Grade, Second Grade, or Third Grade. Pine flooring is first classified as Flat Grain or Comb Grain (sometimes called Edge Grain), and is further graded as Grade A, Grade B, or Grade C.

As will be seen from the stock required to make the flooring, there is considerable loss of surface, owing to the manufacturing. There is also waste in cutting at the job, owing to pieces being rejected. These losses make it necessary to add between one-third and one-half to the floor area, in order to obtain the number of board feet required. If the work is priced on the basis of the square foot of floor surface, this fact must be carefully borne in mind and the unit price must be increased to suit the case.

Wood flooring is generally laid on top of wood underflooring. The underflooring is of ordinary 1" boards, usually T&G and usually laid diagonally across the floor beams; 1"  $\times$  6" boards are most commonly used for this purpose. These are actually only about  $\frac{3}{4}$ " thick and have a face width, when laid, of only  $5\frac{1}{4}$ ". This rough flooring is listed under Rough Carpentry.

Wood flooring is generally scraped and then finished in one of several ways. When these items are called for, they are priced in addition to the flooring itself, on the basis of the number of square feet of floor area. Scraping and finishing are sometimes placed under the heading, Painting, instead of Carpentry. The additional cost runs between 2¢ and 4¢ per square foot for scraping, and between 3¢ and 6¢ for the finishing.

Flooring costs between \$80 and \$100 per M'BM for the material and about the same range for the labor, in the case of regular kinds. This total range of \$160 to \$200 equals about \$225 to \$300 per thousand square feet, or  $22\frac{1}{2}$ ¢ to 30¢ per square foot. As has been stated before, the narrower the board, the greater will be the percentage of waste as a result of forming the tongues and grooves, etc.

Catalogues and some reference books state that allowances of  $33\frac{1}{3}$ %,  $37\frac{1}{2}$ %, and 50% should be added for waste in  $2\frac{1}{4}$ ", 2", and  $1\frac{1}{2}$ " face flooring, respectively. However, because of the additional waste due to cutting to fit around odd-shaped rooms and for pieces that become damaged or are rejected for poor quality, at least 5% more should be added. The estimator must always bear in mind actual job conditions, when judging such matters; and not be influenced by theoretical figures.

*Oak Flooring.* Oak is heavy, hard, and strong. Commercial white oak averages 47 lb. per cu. ft. at 12% moisture content. Commercial red oak averages 44 lb. per cu. ft. at 12% moisture content. Pieces or boards are considered as quartersawn when 80% of the surface shows the radial grain at an angle of  $45^\circ$  or less. Figure 128 shows a quartersawn board (the one taken from the center of the log) and its position in the log. The radiating lines of the medullary rays (shown at the end of the log) lie nearly parallel to the plane of the board, while the growth rings cut across through the board at nearly right angles. As the sawing continues and the quartered boards are cut at distances away from the plane through the center of the log, the angle made by the rays with the plane of the

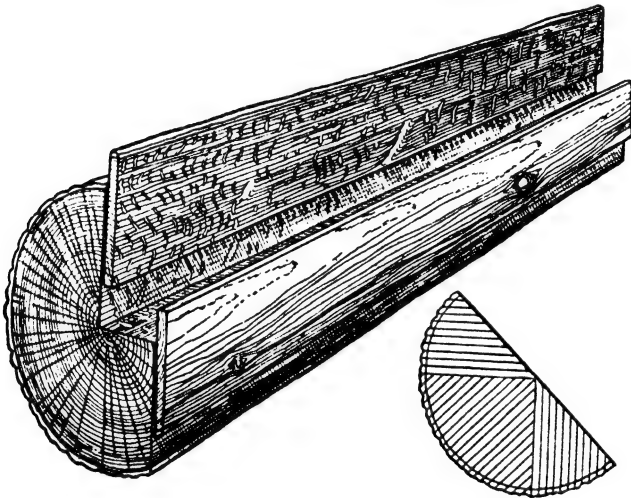


FIG. 128.—Quartersawn and plain-sawn board.

boards increases and, after a  $45^\circ$  angle is obtained, the boards are classed as plain-sawn and partake of the appearance of the board shown coming from the outer portion of the log.

In addition to having desirable beauty, quartersawn material shrinks and swells less than plain-sawn lumber, and it does not surface check or split as much as the plain-sawn kind. It takes about 10 operations with specialized machinery to produce good flooring. After the oak lumber comes from the dry kilns, it is fed through the ripping machines, which cut it into widths suitable for flooring. It then travels on endless chains along the platform and through a planer and a flooring machine. The flooring machine tongues and grooves, hollows the back, and stamps the maker's name and trade-mark on the strips. The strips are next conveyed through an end-matcher machine and are then bundled.

*Maple Flooring.* Maple, beech, and birch are heavy, strong, and hard woods. They are very much alike and sometimes one is substituted

for another. All three are close-grained, hard-fibered, and free from slivering and splintering.

Grades 1, 2, and 3 are the standard commercial grades. The Clear grades are special grades selected for color. First grade is the highest standard grade and is the most durable and desirable for fine homes, churches, dance floors, gymnasiums, public buildings, and other places where appearance as well as durability must be considered. Second grade is practically as serviceable as first grade and has only slight imperfections. Third grade is of poorer quality and shorter lengths, but is suitable for factories, warehouses, workshops, and other places requiring a strong, hard floor.

### Exercises

1. Name 10 items of finish carpentry.
2. Write at least 300 words of notes on finish carpentry from two or three of the books listed in the Preface. Name the books used.
3. Make a list of the names of all the members shown in Figs. 120 to 123, including the masonry and iron items, and give a brief description of the meaning and use of each of these terms.
4. Make a complete estimate of the finish carpentry for the house. The specifications are as follows:

*Materials.* All materials shall be thoroughly seasoned and protected from the weather until placed in the building. All interior trim, including doors, shall be sand-papered before being set in place. The exterior woodwork shall be primed as soon after placing as possible. All tool and erection marks shall be carefully removed from finished surfaces. All workmanship must be perfect. All joints, where possible, shall be tongued and rabbeted together to conceal shrinkage. Exterior wood finish shall be of selected stock white pine. Interior finish shall be southern poplar. Other materials shall be as described below.

*Doors.* Exterior doors shall be of white pine, of the design shown on the drawings, and  $1\frac{3}{4}$ " thick. Interior doors shall be of white pine, six-panel Colonial design,  $1\frac{3}{8}$ " thick, with raised panels. Exterior door frames shall be solid, rabbeted  $1\frac{3}{4}$ " thick white pine. Interior doorjambs shall be  $\frac{7}{8}$ " thick, of poplar or white pine.

*Windows.* Window frames shall be of yellow pine, with pulley stiles  $1\frac{1}{8}$ " thick and with brass  $2\frac{1}{4}$ " pulleys for sash cords or grooved for spiral window adjusters of approved type. Sash shall be check-rail type,  $1\frac{3}{4}$ " thick, of white pine or cypress. The underside of all sash shall be grooved. Provide  $1\frac{1}{8}$ " thick storm sash and  $1\frac{1}{8}$ " thick screens, full length, both of white pine or of cypress, for all windows, including those in the cellar. Provide  $1\frac{3}{8}$ " screen doors for all exterior door openings. All window screens and screen doors shall have copper mesh.

*Interior Trim.* Provide  $\frac{3}{4}$ "  $\times$   $3\frac{3}{4}$ " moulded trim around all doors and windows. Provide  $1\frac{1}{8}$ " stools rabbeted over  $\frac{3}{4}$ "  $\times$   $3\frac{3}{4}$ " moulded aprons in all window openings. Provide  $\frac{3}{4}$ "  $\times$   $3\frac{3}{4}$ " moulded chair rail in dining room. Provide  $\frac{3}{4}$ "  $\times$   $5\frac{1}{4}$ " baseboard, with two mouldings, and  $\frac{3}{4}$ "  $\times$   $4\frac{3}{4}$ " cornice mould throughout, except in the kitchen, bathrooms, garage, and closets. Provide one 12" shelf, a chrome-plated hanger pipe, and  $\frac{3}{4}$ "  $\times$   $3\frac{1}{4}$ " baseboard in all closets, with six shelves in the linen closet. The only trim required in the cellar is a  $\frac{3}{4}$ "  $\times$   $3\frac{1}{4}$ " moulded frame around each window.

*Porches.* All the porch work shall be of white pine throughout, put together in substantial style, all joints being housed where possible, and all joints being set in white lead.

*Stairs.* Stairs, from cellar to second floor shall have 2"  $\times$  12" carriages, set not more than 16" centers; 1 $\frac{1}{8}$ " oak treads;  $\frac{7}{8}$ " poplar or white-pine risers; 1 $\frac{1}{8}$ " square balusters, set three to a tread; and 3 $\frac{1}{4}$ "  $\times$  3 $\frac{1}{4}$ " moulded oak newel posts. Treads and risers shall be mortised together, wedged, and glued. Provide moulded oak 2 $\frac{1}{4}$ "  $\times$  2 $\frac{1}{4}$ " handrails.

*Flooring.* Lay Florian deadening felt, well lapped, on the subflooring throughout, except in the kitchen and rear entry. Lay flat grain B-grade pine flooring,  $\frac{3}{4}$ "  $\times$  2 $\frac{1}{4}$ " face T&G, in the kitchen and the rear entry. Lay No. 1 Quartered White Oak flooring in the living room and first-floor hall. Lay No. 2 plain-sawed white oak in all the other spaces throughout the first and second floors, except in the bathrooms. All the oak flooring shall be 2 $\frac{5}{32}$ "  $\times$  2 $\frac{1}{4}$ ", side and end matched, and shall be laid and nailed in perfect manner. Scrape and sand all flooring. Finish all the oak flooring by applying a water stain, sanding, filling, shellacking, waxing, rubbing, waxing again, and polishing. Finish the stair treads in the same manner as the oak flooring.

*Mantel.* Provide a mantel for the living room. This shall be constructed in true "cabinet" style, of poplar, with two fluted pilasters at each side, a fascia about 10" wide, three lines of mouldings on the fascia and one along the edge of the shelf, and a shelf 1 $\frac{1}{8}$ "  $\times$  7 $\frac{1}{4}$ ".

*Kitchen Cabinets.* Provide a complete set of kitchen cabinets, as shown on the details. These shall be made up in true "cabinet" style and finished in the factory with a priming coat and with two coats of white enamel on the inside and three coats on the outside. Include chrome-plated brass hardware, pan racks, breadbox lining, decorative frieze, ventilated sink-front enclosure, and approved counter and sink tops and splash back of linoleum with heavy chrome-plated brass edgings.

*Other Items.* Provide all other items of finish carpentry as required to complete the work, including exterior and interior trim, gable louvers, overhead door-frame, garage rack, etc. The overhead door is specified under a separate heading. The kitchen floor will be linoleum and is specified under a separate heading.

## CHAPTER XVIII

### STEEL AND IRON

The subcontractors for steelwork include all the steel columns, girders, and beams, and the steel plates and connections that go with these items. They also include the heavier types of steel lintels and any special steel framing that may be required for tank and machinery supports and other purposes, in addition to that for the general support of the building. If there are steel trusses, these also would be figured by the steel contractors' estimators.

The subcontractors for ornamental and miscellaneous ironwork include all the steel and iron items called for on the plans and in the specifications, except those that are put under the structural-steel heading. Sometimes there is a question as to the heading under which certain items should be entered. Small items of steel, especially those that are plain members or that do not frame into other steel, are examples. It is part of the general contractor's work of coordinating the trades to see that questionable items are taken care of by one or the other of steel and iron contractors.

Occasionally, one subcontractor will include all the structural steel and the miscellaneous and ornamental iron. This happens especially when there is a considerable amount of ironwork and only a few items of structural steel.

**Structural Steel.** To compute the cost of the structural steel, the steel estimators first list all the pieces of steel shown on the plans. The cross-section type and size, the length, and the weight per linear foot are generally taken. The extensions are made in tons, and the work is priced on that basis. Some of the factors considered in making up the estimated cost are shop drawings, erection drawings, time for delivery, mill or stock material, fabrication, shop painting, freight, trucking, steel members, rivets, welding, bolts, connections, bearing plates, unloading, erection, equipment, scaffolding, planking, field painting, foremen, insurance, general job expense, overhead expense, and profit.

If inspection of the structural steel is called for, either at the steel plant or the fabricating shop or at the job, the expense in connection with this must be considered, also. Perhaps the specification makes a lump-sum allowance for this purpose or specifies the name of an inspection concern to do the inspecting. In addition to this element of cost, which may

have to be included by the general contractor's estimator instead of by the steel contractor, other items require careful consideration. The shop or erection drawings are sometimes so specified that the general contractor has to judge the cost and make a suitable entry in the general estimate, instead of having the steel contractors include such cost in their estimates to him.

Steel specifications often call for the grouting or bedding of the steel members that bear on concrete or masonry. This work is practically never included by the steel contractors, and the general contractor's



FIG. 129.—A steel-frame building.

estimator must therefore make sure that the cost is covered in his estimates for the concrete or masonry work.

The student should become aware of the fact that architects assume no responsibility for the correctness of shop drawings and schedules sent to them for approval, in any line of work, even if they sign the drawings or schedules as meeting with their approval. The approval is always understood to cover the general design of the work only and not the correctness of the detail members or measurements, or the fitting together of the work in the job. Too many contractors rely on the architect's approval of the drawings submitted by themselves or by their subcontractors. This approval does not constitute a thorough check of the drawings. Neither does an architect guarantee that various drawings sent in by subcontractors in different trades coordinate with one another. This all means

that the estimator has to consider carefully any cost items of this sort that come to his mind in estimating. He may have to make the drawings himself for some of the subcontractors, or he may have a lot of trouble checking and correcting drawings. It may even be necessary for him to reconsider the type of subcontractors that his firm plans to use on a particular job.

The contractor assumes practically all the responsibility for the job, once he has signed the contract. He may pass along considerable of this responsibility to his subcontractors and, of course, this is what he should do, because they are the experts and specialists in their own fields of work and may, therefore, be expected to undertake the responsibilities that their work entails. The estimator must see that subcontracts are so worded that the subcontractors take the whole of their fair share of responsibility. The estimator should also endeavor to have his firm's interests properly covered in the general contract with the owner. Contractors are too prone to sign the contract form that is given them by the architect (and usually double-checked beforehand by the owner or the owner's lawyer) without considering whether changes or additional clauses might not reasonably be requested by himself, the better to protect his own interests.

The steel framework of buildings is made up mainly of H-columns, I-beams, channels, and angles. This is all highly standardized. Reference lists like the following tables are used by architects and engineers

WIDE-FLANGE I-BEAMS

| Size,<br>in. | Lb. per<br>ft. | Size,<br>in. | Lb. per<br>ft. | Size,<br>in. | Lb. per<br>ft. | Size,<br>in. | Lb. per<br>ft. | Size,<br>in. | Lb. per<br>ft. | Size,<br>in. | Lb. per<br>ft. |
|--------------|----------------|--------------|----------------|--------------|----------------|--------------|----------------|--------------|----------------|--------------|----------------|
| 27           | 163            | 21           | 132            | 16           | 96             | 14           | 84             | 12           | 72             |              | 21             |
|              | 145            |              | 112            |              | 88             |              | 78             |              | 65             |              | 19             |
|              | 106            |              | 96             |              | 78             |              | 74             |              | 58             |              | 17             |
|              | 98             |              | 82             |              | 71             |              | 68             |              | 53             |              | 15             |
|              | 91             |              | 73             |              | 64             |              | 61             |              | 45             | 8            | 40             |
| 24           | 150            |              | 68             |              | 58             |              | 53             |              | 40             |              | 35             |
|              | 130            |              | 63             |              | 50             |              | 48             |              | 36             |              | 31             |
|              | 120            |              | 59             |              | 45             |              | 43             |              | 28             |              | 27             |
|              | 100            | 18           | 114            |              | 40             |              | 38             |              | 25             |              | 24             |
|              | 87             |              | 105            |              | 36             |              | 34             |              | 22             |              | 21             |
|              | 80             |              | 96             |              |                |              | 30             |              | 19             |              | 17             |
|              | 74             |              | 85             |              |                |              |                | 10           | 66             |              | 15             |
|              |                |              | 77             |              |                |              |                |              | 54             |              | 13             |
|              |                |              | 70             |              |                |              |                |              | 49             | 6            | 16             |
|              |                |              | 64             |              |                |              |                |              | 41             |              | 12             |
|              |                |              | 55             |              |                |              |                |              | 33             |              |                |
|              |                |              | 50             |              |                |              |                |              | 26             |              |                |

## STANDARD I-BEAMS

| Size, in. | Lb. per ft. | Size, in. | Lb. per ft. | Size, in. | Lb. per ft. |
|-----------|-------------|-----------|-------------|-----------|-------------|
| 24        | 105.9       | 18        | 54.7        | 10        | 35.0        |
|           | 100         | 15        | 50.0        |           | 25.4        |
|           | 90          |           | 42.9        | 8         | 23.0        |
|           | 79.9        | 12        | 50.0        |           | 18.4        |
| 20        | 95.0        |           | 40.8        | 7         | 15.3        |
|           | 85          |           | 35.0        | 6         | 17.25       |
|           | 75          |           | 31.8        |           | 12.5        |
|           | 65.4        |           |             | 5         | 10.0        |
|           |             |           |             | 4         | 9.5         |
|           |             |           |             |           | 7.7         |
|           |             |           |             | 3         | 7.5         |
|           |             |           |             |           | 5.7         |

## STANDARD CHANNELS

| Size, in. | Lb. per ft. | Size, in. | Lb. per ft. | Size, in. | Lb. per ft. |
|-----------|-------------|-----------|-------------|-----------|-------------|
| 18        | 58          | 10        | 30          | 7         | 14.75       |
|           | 51.9        |           | 25          |           | 12.25       |
|           | 45.8        |           | 20          |           | 9.8         |
|           | 42.7        |           | 15.3        | 6         | 15.5        |
| 15        | 55          | 9         | 20          |           | 10.5        |
|           | 50          |           | 15          |           | 8.2         |
|           | 40          |           | 13.4        | 5         | 9.0         |
|           | 33.9        | 8         | 18.75       |           | 6.7         |
| 12        | 30          |           | 13.75       | 4         | 7.25        |
|           | 25          |           | 11.5        |           | 6.25        |
|           | 20.7        |           |             |           | 5.4         |
|           |             |           |             | 3         | 6.0         |
|           |             |           |             |           | 5.0         |
|           |             |           |             |           | 4.1         |

## EQUAL-LEG ANGLES

| Size, in.   | Lb. per ft. | Size, in.   | Lb. per ft. | Size, in.  | Lb. per ft. |
|---|-------------|---|-------------|--|-------------|
| $8 \times 8 \times 1$                                 | 51.0        | $5 \times 5 \times \frac{3}{4}$                       | 23.6        | $3 \times 3 \times \frac{3}{8}$                        | 7.2         |
|   | 45.0        |   | 20.0        |  | 6.1         |
|   | 38.9        |   | 16.2        |  | 4.9         |
|   | 32.7        |   | 12.3        |  | 5.9         |
| $6 \times 6 \times \frac{1}{2}$                       | 26.4        | $4 \times 4 \times \frac{5}{8}$                       | 15.7        | $2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$ | 5.0         |
|   | 33.1        |   | 12.8        |  | 4.1         |
|   | 28.7        |   | 9.8         |  | 3.07        |
|   | 24.2        |   | 8.2         |  | 3.92        |
| $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$ | 19.6        | $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$ | 11.1        | $2 \times 2 \times \frac{1}{4}$                        | 3.19        |
|   | 14.9        |   | 8.5         |  | 2.44        |
|   |             |   | 7.2         |  |             |
|   |             |   | 5.8         |  |             |

## UNEQUAL-LEG ANGLES

| Size, in.                       | Lb. per ft. | Size, in.                                  | Lb. per ft. | Size, in.  | Lb. per ft. |
|---------------------------------|-------------|--|-------------|--|-------------|
| $8 \times 6 \times \frac{7}{8}$ | 39.1        | $5 \times 3\frac{1}{2} \times \frac{5}{8}$ | 16.8        | $3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$  | 7.2         |
| $\frac{3}{4}$                   | 33.8        | $\frac{1}{2}$                              | 13.6        | $\frac{3}{16}$   | 6.1         |
| $\frac{5}{8}$                   | 28.5        | $\frac{3}{8}$                              | 10.4        | $\frac{1}{4}$  | 4.9         |
| $\frac{1}{2}$                   | 23.0        | $\frac{5}{16}$                             | 8.7         | $3 \times 2\frac{1}{2} \times \frac{3}{8}$             | 6.6         |
| $8 \times 4 \times \frac{3}{4}$ | 28.7        | $4 \times 3\frac{1}{2} \times \frac{1}{2}$ | 11.9        | $\frac{5}{16}$   | 5.6         |
| $\frac{5}{8}$                   | 24.2        | $\frac{3}{8}$                              | 9.1         | $\frac{1}{4}$  | 4.5         |
| $\frac{1}{2}$                   | 19.6        | $\frac{5}{16}$                             | 7.7         | $3 \times 2 \times \frac{3}{8}$                        | 5.9         |
| $7 \times 4 \times \frac{5}{8}$ | 22.1        | $4 \times 3 \times \frac{1}{2}$            | 11.1        | $\frac{5}{16}$   | 5.0         |
| $\frac{1}{2}$                   | 17.9        | $\frac{3}{8}$                              | 8.5         | $\frac{1}{4}$  | 4.1         |
| $\frac{7}{16}$                  | 15.8        | $\frac{5}{16}$                             | 7.2         | $2\frac{1}{2} \times 2 \times \frac{3}{8}$             | 5.3         |
| $\frac{3}{8}$                   | 13.6        | $\frac{1}{4}$                              | 5.8         | $\frac{5}{16}$   | 4.5         |
| $6 \times 4 \times \frac{5}{8}$ | 20.0        | $3\frac{1}{2} \times 3 \times \frac{1}{2}$ | 10.2        | $\frac{1}{4}$  | 3.62        |
| $\frac{1}{2}$                   | 16.2        | $\frac{3}{8}$                              | 7.9         | $\frac{3}{16}$   | 2.75        |
| $\frac{7}{16}$                  | 14.3        | $\frac{5}{16}$                             | 6.6         | $2\frac{1}{2} \times 1\frac{1}{2} \times \frac{5}{16}$ | 3.92        |
| $\frac{3}{8}$                   | 12.3        | $\frac{1}{4}$                              | 5.4         | $\frac{1}{4}$  | 3.19        |
|                                 |             |  |             | $\frac{3}{16}$   | 2.44        |

when they design the structure and by steel contractors when they prepare the material lists and schedules. The tables give only the more commonly used sizes and the weights per linear foot. The wide-flange I-beams are used also for columns.

**Steel Costs.** Structural steelwork usually costs the general contractor between \$130 and \$150 per ton in place. About 4% for rivets and bolts is added to the total weight of the members listed from the plans. Between 15% and 20% is added for connections and other details. For every ton of steel about \$2 is added for the cost of the many drawings required. The shop painting of the steel costs between \$10 and \$12 per ton of steel. Thus, by the time the steel arrives at the job, the cost is around \$70 per ton. Before any of it can be erected, the steel contractor sends a considerable amount of equipment to the job. This may include derricks, cranes, hoisting engines, tackle, scaffold planks, a shanty, and an assortment of small tools. Getting all this to the job, installing it in readiness to start operations, maintaining it in good order while the job is under way, dismantling it, and finally removing it from the job are all necessary elements of cost. Setting up a large derrick alone may cost \$200. The labor of unloading and erecting the steel will depend upon the type of building, the accessibility of the work, and the amount of steel involved. Riveting or welding, field painting, and other items of direct job cost require consideration also, and the insurance, general expense, and overhead expense must be considered before adding the profit. The cost of workmen's compensation insurance for erecting

structural steel amounts to about 42% of the job pay roll. Thus, if a small building requires a steel gang for about two weeks and the pay roll amounts to \$1,200, an amount of \$504 must be added to cover this one form of insurance alone.

**Miscellaneous Iron.** To compute the cost of the miscellaneous and ornamental ironwork, the iron subcontractors' estimators list their work much as the general contractor's estimator lists millwork. Some of the items, like stairs, fire escapes, door bucks, lintels, and other commonly used items, have become standardized and require only simple listing of

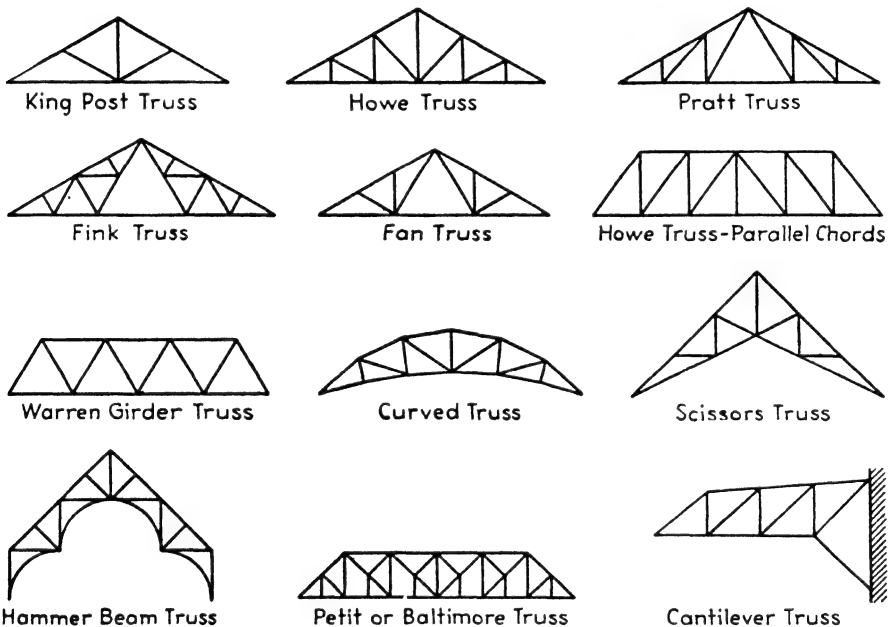


FIG. 130.—Types of steel trusses.

the amounts and sizes. Special ornamental railings, grilles, curved features, and other decorative work, however, require careful study of the plans and specifications and careful analysis of the costs involved. Stairs cost between \$90 and \$125 per story for plain work. Ordinary fire escapes cost between \$75 and \$100 per story. Door bucks, plain grilles, plain window guards, and other simple items of ironwork cost between \$10 and \$25 each.

The specification division dealing with miscellaneous ironwork is one that demands careful scrutiny by estimators. Architects use this as a division into which they may throw many items of a special nature that should have special headings, and also, some that are already covered under Masonry, Carpentry, or other headings, besides the ironwork heading.

Subcontract bids may read "For all the Misc. Ironwork" or "For all the Ornamental Ironwork" or other wording that does not mean to include everything that is in the architect's specification division referred to. It is the estimator's task to make a list of possible items that he thinks will need checking. Wirework, bronze and other nonferrous items, safety treads, masonry anchors, flagpoles, metal chimneys, coal doors, ash hoists, awning boxes, steel sash, metal toilet partitions, and fittings of various kinds are some of the things that are often thrown into the iron specifications by the architect or the specification writer. The

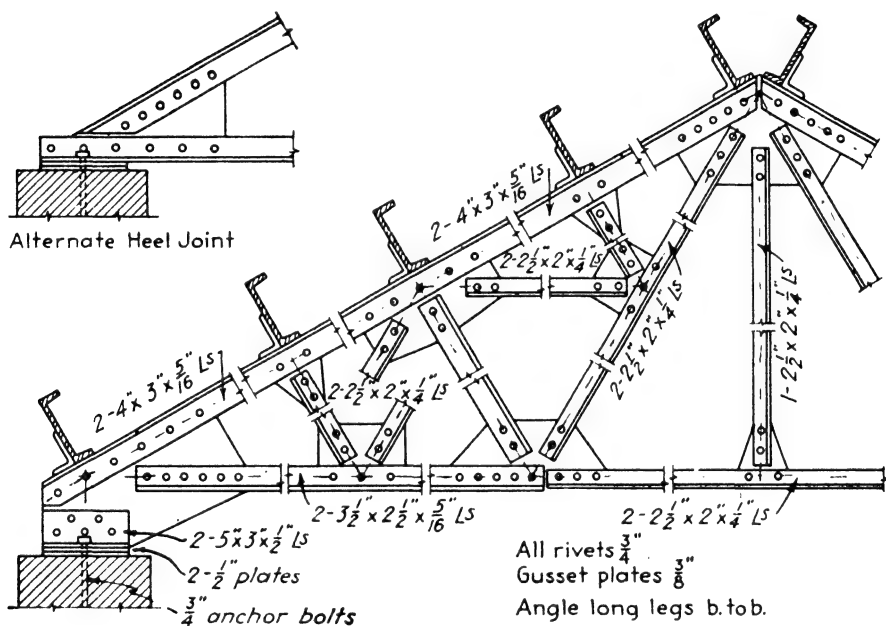


FIG. 131.—Truss details.

estimator usually has to pull these items out and make special headings in his estimate for them or include them in other divisions of his estimate.

Generally speaking, the miscellaneous ironwork includes area gratings, covers and frames, coal chutes, door bucks, ladders, sidewalk doors, steel stairs, wheel and corner guards, curb angles, etc.

Ornamental iron includes grilles, balconies, lamp standards, ornamental brackets, ornamental railings, iron canopies, and special iron construction for decorative purposes.

The iron subcontractors usually suit themselves as to which items on a job they will include in their bids. Some submit, along with their bids, a list of the items included. It frequently happens that a few items are left hanging, being covered by neither sub-bids nor material quotations. The general contractor's estimator then has to scout around and get

prices on them or price them himself. Loose lintels, intended to be set by the masons, are often omitted both by the steel contractors and by the iron contractors.

Many items of steel and iron are handled and set by the concrete workers or by the masons, and the cost of this handling and setting must be provided for under the appropriate heading in the estimate. Anchors, inserts, sockets, safety treads, gratings, doorframes, guards, curb angles, bearing plates, and small steel lintels are some of these items.

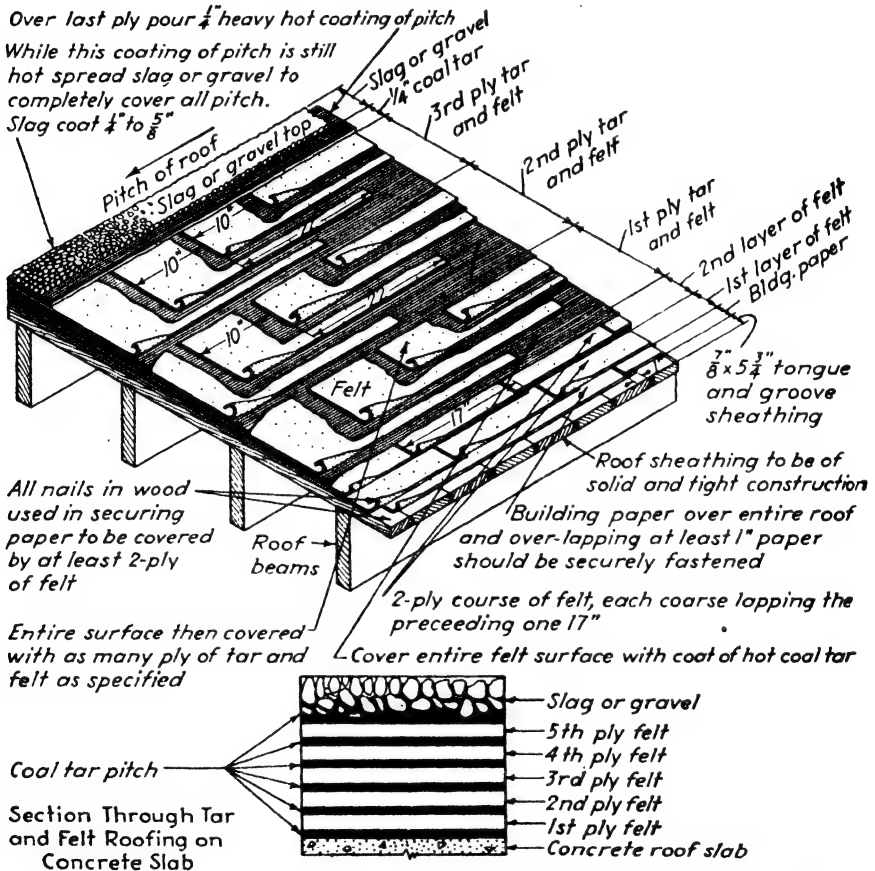
### Exercises

1. Make sketches of four typical steel sections; name them and put dimensions on them.
2. What is an average price for structural steel-work, in place?
3. List the items shown on the house plans that would be included under the heading of steel and ironwork.
4. List the items shown on the plans in Chap. XXV that would be included under Structural Steel.
5. List the items shown on the plans in Chap. XXV that would be included under Miscellaneous and Ornamental Iron.

## CHAPTER XIX

### ROOFING AND SHEET METALWORK

These two lines, roofing and sheet metalwork, are practically always handled as one subcontract. The work involves the roof coverings and



Composition (slag or gravel) roof over concrete similar to wood excepting the use of the building paper and untarred felt which is eliminated. The hot coal tar is applied directly to the concrete and then following with as many ply as required, the average good roof is 5 ply

FIG. 132.—Built-up roofing.

flashings, metal leaders and gutters, skylights, wire guard screens, ventilating ducts, registers, etc.

**Roofing.** Built-up, or "composition," roofing consists of several layers of felt and asphalt (or tar). The asphalt or tar is applied hot, with mops. Asphalt is refined from a natural substance found in large deposits in Trinidad and Venezuela. On top of the several layers, a surface coating of fine gravel or slag or a layer of smooth or mineral surfaced roofing is applied. The number of layers and the surface finish are, of course, given in the specifications. Slate roofing is made in shingle form, usually measuring  $12'' \times 16''$  or  $14'' \times 20''$ , and the thickness of commercial grades runs between  $\frac{3}{16}''$  and  $\frac{1}{4}''$ . Other forms of roofing also are used, such as copper, zinc, and asbestos. Asbestos shingles, imitating the appearance of wood shingles, are available. All

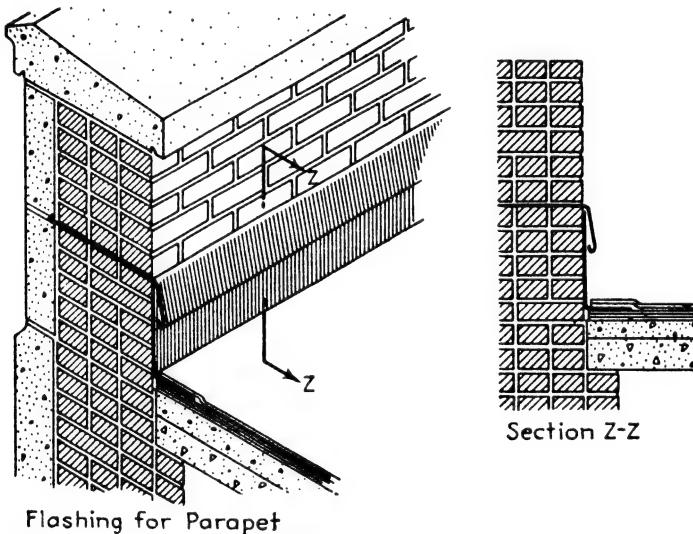


FIG. 133.—Wall flashing.

roofing is measured by the square foot or by the square containing 100 sq. ft.

Composition roofing costs the general contractor between 10¢ and 15¢ per square foot. Asbestos, clay tile, slate, and other heavy types of roofing run between 25¢ and 75¢ per square foot, depending upon the quality, shapes, colors, and amounts involved.

**Flashings.** The joints between the roof covering and the adjoining higher walls, chimneys, etc., are sealed with flashings. Strips of copper, galvanized-iron or composition sheets, or plastic materials are used for this purpose. The valleys in roofs are similarly flashed. These are measured in linear feet of each kind, and the material and width are noted.

Reglets formed or cut in the walls for cap flashings are sometimes specified under Roofing, and may not be specified or shown elsewhere.

Inasmuch as the roofers will probably not include these in their bids, the estimator must provide for the expense involved under Masonry or some other appropriate heading. If, however, a patented type of reglet is

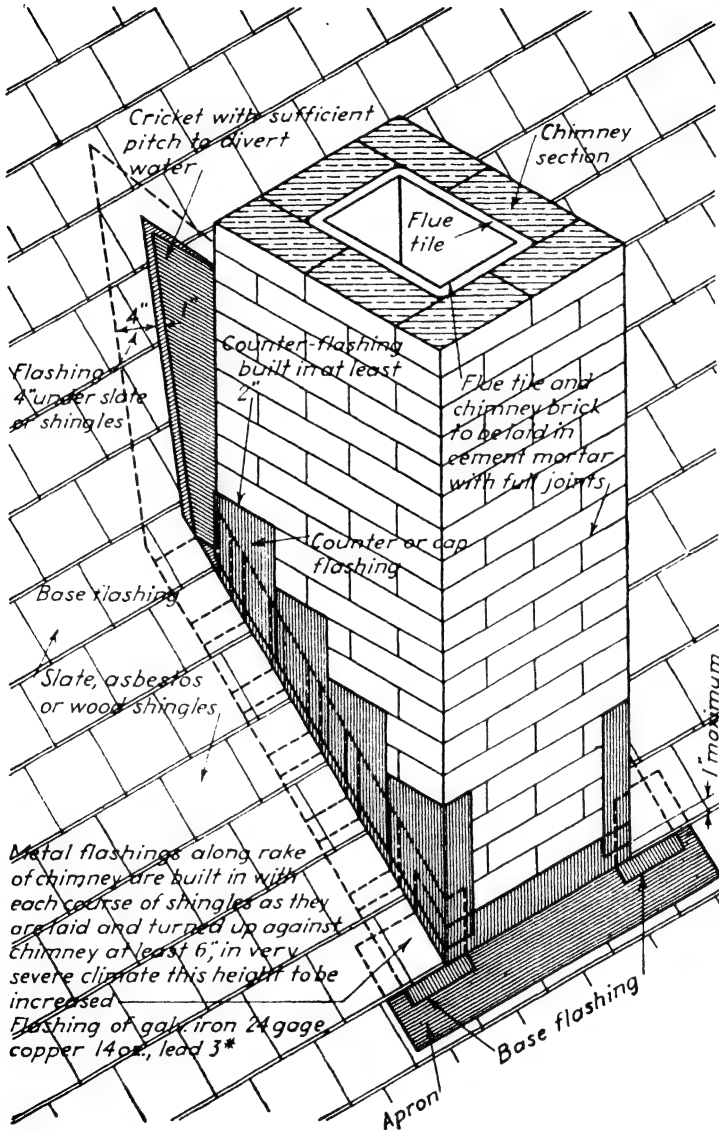


FIG. 134.—Chimney flashing.

called for, it will probably be included by the roofers. No definite general rules can be laid down covering items that may or may not be included in subcontractors' bids; therefore, the student must realize the

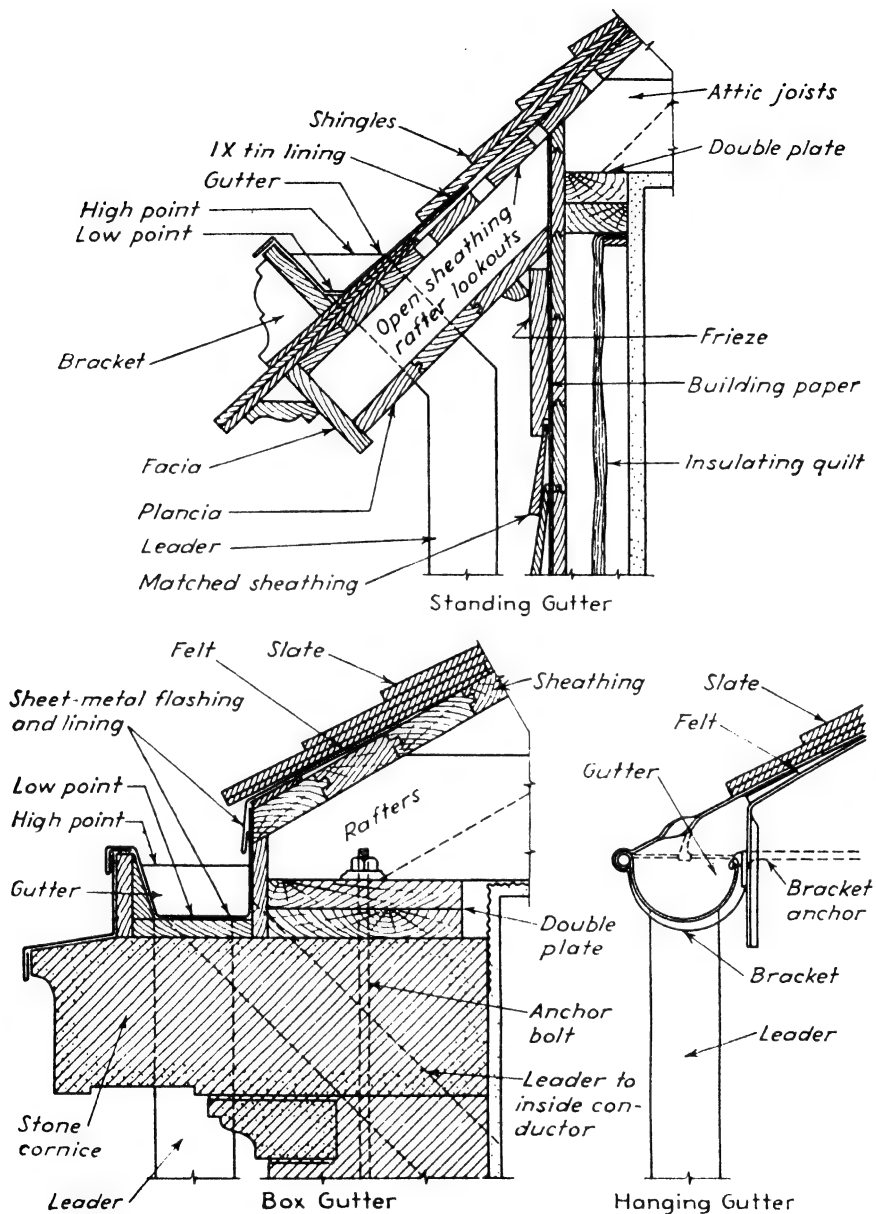


FIG. 135.—Gutters and leaders.

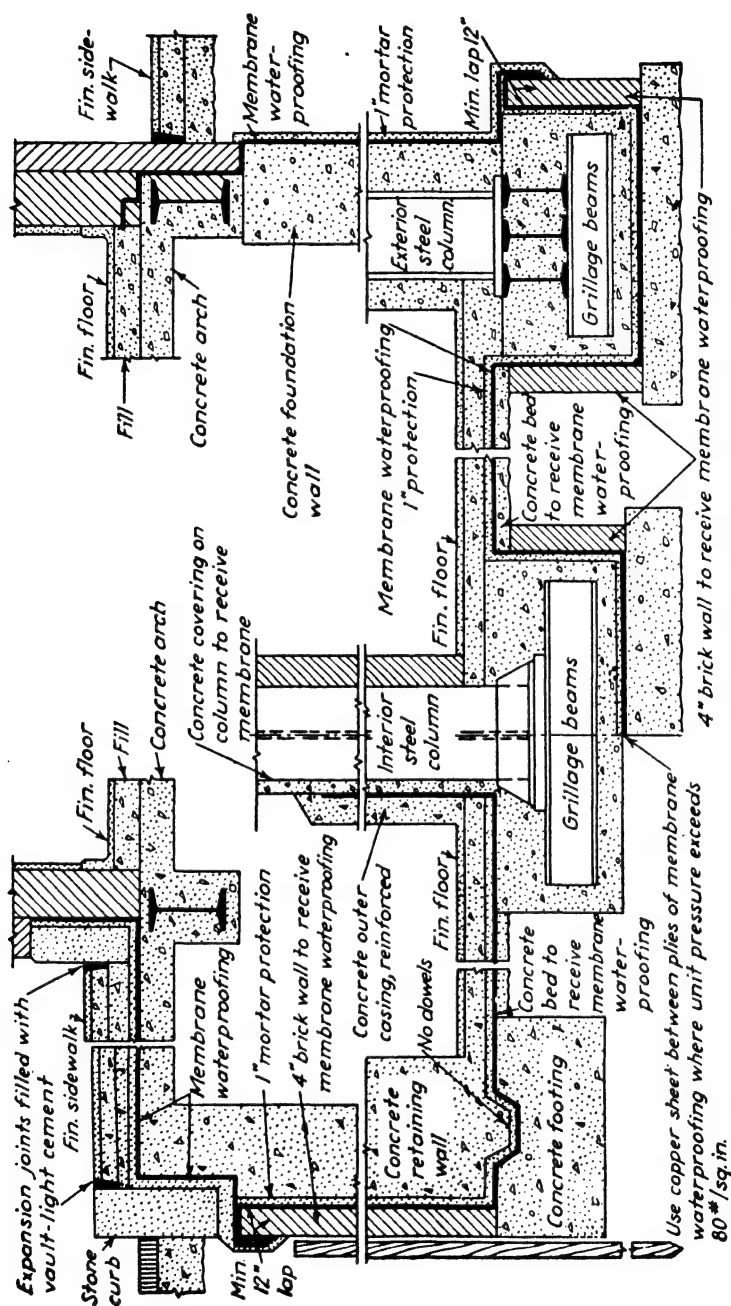


Fig. 136.—Cellar waterproofing.

importance of taking care in analyzing these bids. Experience along this line is necessary.

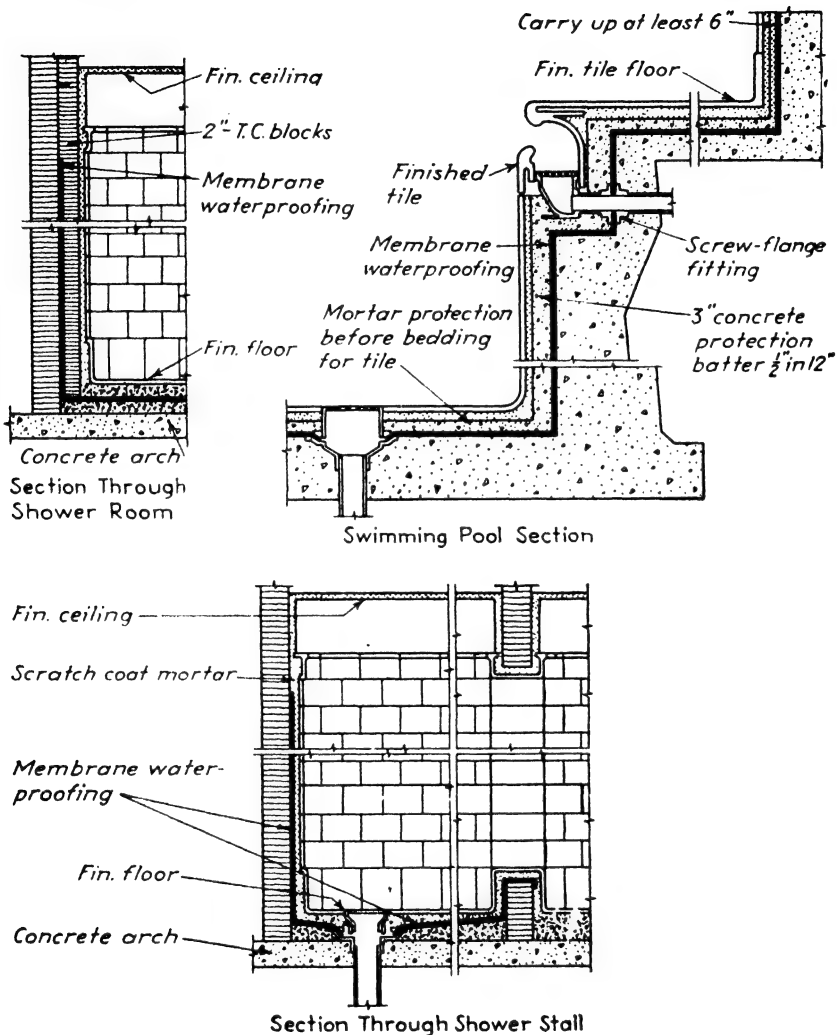


FIG. 137.—Shower rooms and swimming pool.

Ordinary plastic flashing costs about 12¢ per linear foot. Galvanized-iron flashings cost about 20¢ and copper flashings about 60¢ per linear foot.

**Gutters.** Gutters are hung on the bottom edges of sloping roofs or are formed in the roofs themselves. Copper is the material most generally used for gutters and gutter linings. For estimating purposes, a sketch

of the gutter giving the shape and size is required, together with the number of linear feet and a notation as to the kind of material called for.

Metal cornices, which are included under this heading, often require special analysis. Plain cornices of metal are measured in linear feet and the full width of the metal is noted, together with a sketch showing the profile.

Copper gutters and leaders cost the general contractor about 50¢ to 60¢ per linear foot. Plain cornices of galvanized iron cost about \$1.50 per linear foot for small sizes and those of copper about \$2.00 per linear foot. Large and decorated cornices easily cost twice as much or more.

**Skylights.** Skylights, which are of many types, require careful listing as to size, shape, kind of metal, glass, ventilating openings, etc. Galvanized-iron skylights cost about \$18 apiece for small ones two or three feet square, \$50 apiece for those of about five feet. Copper skylights are much more expensive. A large one, say 8'0" × 15'0", with ventilators, might cost \$500 to \$600. The glass used in skylights is always included with the skylights and is not listed under the regular glass heading.

**Ducts.** Plain ventilating duct work is listed in linear feet. The cross-section size is given. All bends and special shapes are carefully counted and described separately. Items of registers, louvers, and other fittings and supplies are also listed and described separately. Straight duct work in galvanized iron, 12" × 12" in cross section, will cost about \$1.25 per linear foot, and each intersection or bend in it will cost \$4 to \$6 extra.

**Waterproofing.** Membrane waterproofing is similar to composition roofing work and is done by the roofers. It consists of several layers of felt or burlap, each embedded in hot asphalt or tar, and is applied on foundation walls and in bathrooms, showers, and other locations requiring such protection. This work is measured in square feet, and the cost is generally between 10¢ and 20¢ per square foot.

### Exercises

1. List the items of work generally included under Roofing and Sheet Metal, and give opposite each one the unit of measure used and an average price per unit.
2. Make an approximate estimate of all the Roofing and Sheet Metalwork for the plans shown in Chap. XXV.
3. Make a good estimate of all the Roofing and Sheet Metal for the house plans. The specifications are as follows:

Flash the walls with 16 oz. copper, extending at least 10" on the roofs and 8" on the walls and provided with copper cap flashing set into the walls. Flash the chimney with copper step flashing and cap flashing. Flash the heads of all the outside windows and doors with 16 oz. copper. Flash the valleys with 16 oz. copper at least 18" wide.

Install heavy moulded copper gutters and leaders and leader boxes, as shown on the plans and details.

Install copper boxes, No. 16 ga., in the wooden flower boxes.

Apply tin roofing, laid flat, locked together, and soaked with solder, on the bay-window roofs. This shall be fastened to the sheathing by cleats 8" apart, cleats locked into seams of the tin and secured with two 1" barbed nails. Run the tin up 4" under the wall shingles and counter flash with sheet lead. Form a 1" drip along outer edges of roofs. All inaccessible surfaces of the tin shall be given one good coat of red lead.

Lay slaters' felt, well lapped, on all other roof surfaces. Lay Black Pennsylvania slate shingles, 12"  $\times$  16"  $\times$   $\frac{1}{4}$ " thick, over all the felt. The slate shall be laid "American" method, with shingled ridges and "Boston" hips, and it shall be laid in regular courses, lapped 8", and be secured with copper slaters' nails.

## CHAPTER XX

### STONEMWORK

**Stonework** is a general term for several divisions that may be required in the estimate. Some subcontractors handle several kinds of stone, others only one.

Plain cellar walls or other walls of rubble stone are measured in cubic feet. However, rubble stonework is more often included with the regular Masonwork instead of being treated as a subcontract item.

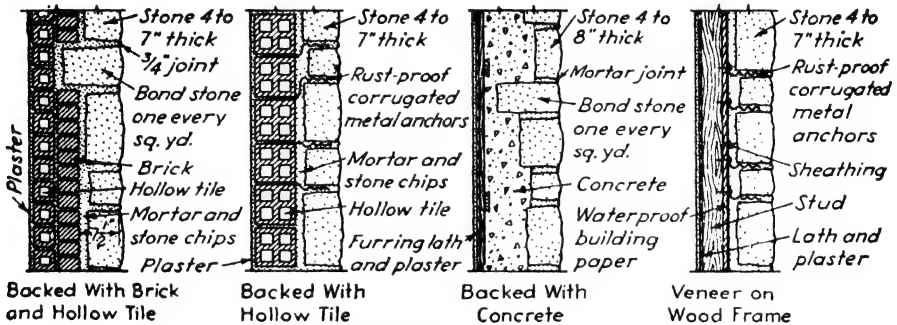


FIG. 138.—Rock-face ashlar.

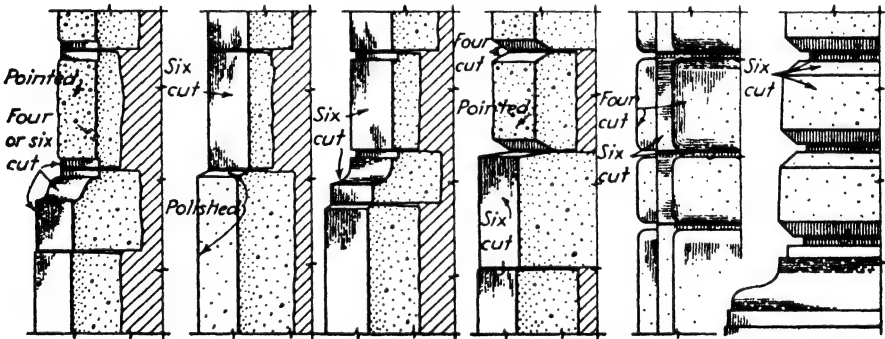


FIG. 139.—Stone base courses and walls.

Granite and limestone are the two kinds of stone most commonly used for facing purposes; but bluestone also is used, especially for sills, copings, lintels, and curbing.

Cast stone is an artificial stone which, by the right combination of the proper ingredients, can be made to imitate any of the natural stones.

All the different kinds of stone are measured in approximately the same manner for estimating. The plain work of ashlar facing is measured in square feet. Curbs and copings are measured in linear feet. Sills,

lintels, keystones, and other small units are counted per piece. Special shapes are analyzed and, in the case of cut stone, the size of the block from which each piece will be cut is taken into account.

**Costs.** Plain rubble walls cost between 45¢ and 65¢ per cubic foot, plus about 25¢ if they are laid up and pointed for better appearance.

Limestone and the better grade of cast stones run between \$2 and \$4 per square foot for ashlar wall facing. Plain sills, lintels, keystones, etc., of these materials or of bluestone cost between \$5 and \$10 each. Note that these small isolated pieces are merely furnished by the stone sub-

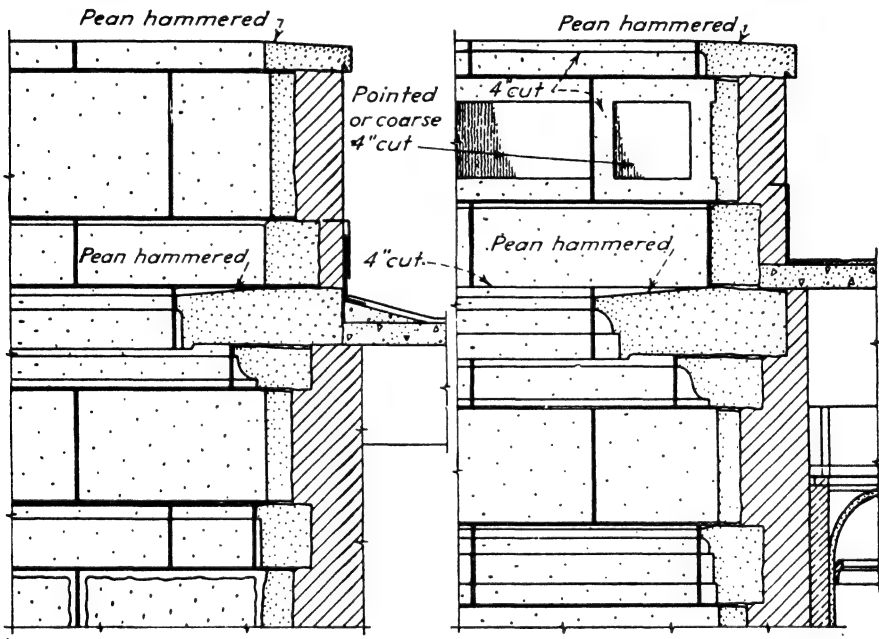


FIG. 140.—Stone cornices and parapets.

contractor if they go in brick walls. In this case the bricklayers set them, and this setting cost is figured under Masonwork.

Stone trim around an ordinary-sized door or window opening may cost about \$50, and an elaborate entrance doorway of stone may run to \$1,000.

A granite step may cost \$100 and the granite base course of a building will run between \$5 and \$15 per linear foot.

#### Exercises

1. Name four kinds of stone and state what each is suitable for.
2. List the items shown on the house plans that would be included under the heading of Stonework.
3. List the items on the plans in Chap. XXV that would be included under Stonework.

## CHAPTER XXI

### FIREPROOF DOORS AND WINDOWS

This chapter deals with kalamein doors and windows, windows and doors of steel or hollow metal, show-window construction, and special types of fireproof doors. On a large job each would probably have a separate division in the estimate, while on a small job some or all of them might be included under Carpentry.

Fireproof doors and windows are required by law in certain locations, as in fireproof buildings and in the boiler rooms, public halls, and elevator shafts of nonfireproof buildings of some types. Insurance requirements also call for fireproof protection of this nature if the buildings are to be insured. The tinclad or other types of "fire doors" are especially required by insurance regulations.

Combination frames and trim for doors are obtainable and are popular in use with wood doors, as well as with fireproof doors. These are made of sheet steel bent to the shape of frame and trim. They come all made up as a unit, ready to be installed in place, and have suitable notches in them for the hinges and for the lock strikes.

**Kalamein.** Kalamein work refers to that type of construction in which sheet metal is built on a wood core. This is done in the shop. The ordinary type of fireproof door, such as entrance doors to individual apartments in a modern apartment house, is a kalamein door.

Ordinary kalamein doors cost about \$15 each for the door, delivered, and the combination pressed-steel frames that are generally used with them cost about \$7, delivered. A complete assembly of frame, door, and hardware with spring hinges with a cylinder lock set, will cost between \$33 and \$40, installed in place.

Tinclad fire doors are made of a wood core covered with one or more layers of tin, and are especially resistant to high temperatures. This is a type of kalamein work, but it is of such special nature that the doors are always called "fire doors" or "tinclad doors" or "tinclad Fire Underwriters' doors," to distinguish them from the ordinary kalamein door.

A regulation fire door, set, costs between \$150 and \$250 for an opening of ordinary size. The cost depends mainly upon whether a single door is suitable or whether a door on each side of the opening is required.

Fireproof windows are made of kalamein, hollow-metal, and steel construction. Steel factory sash and residence steel casements are of the

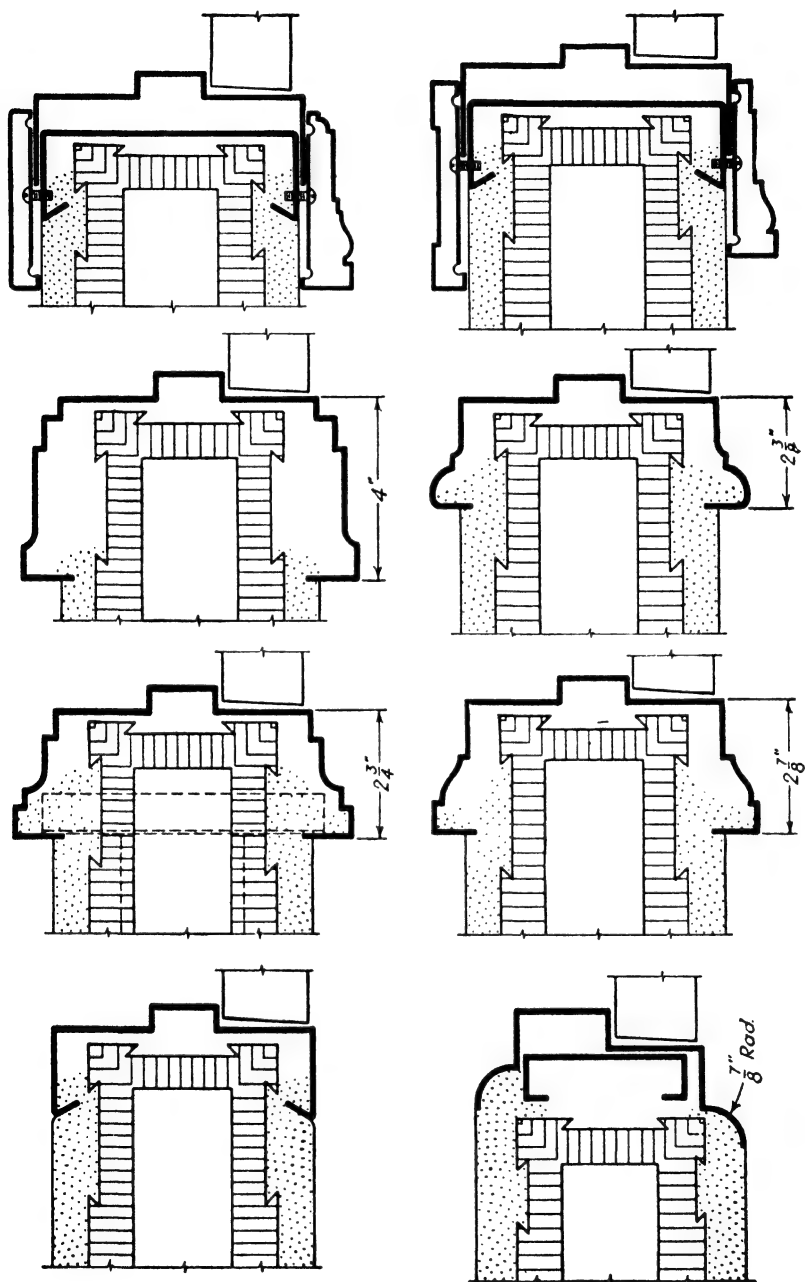
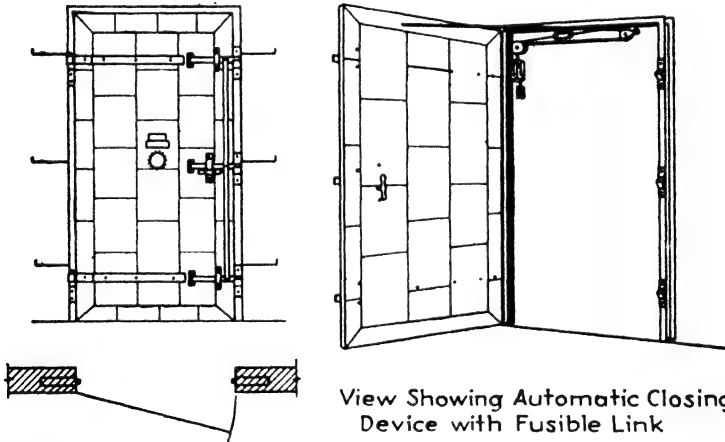
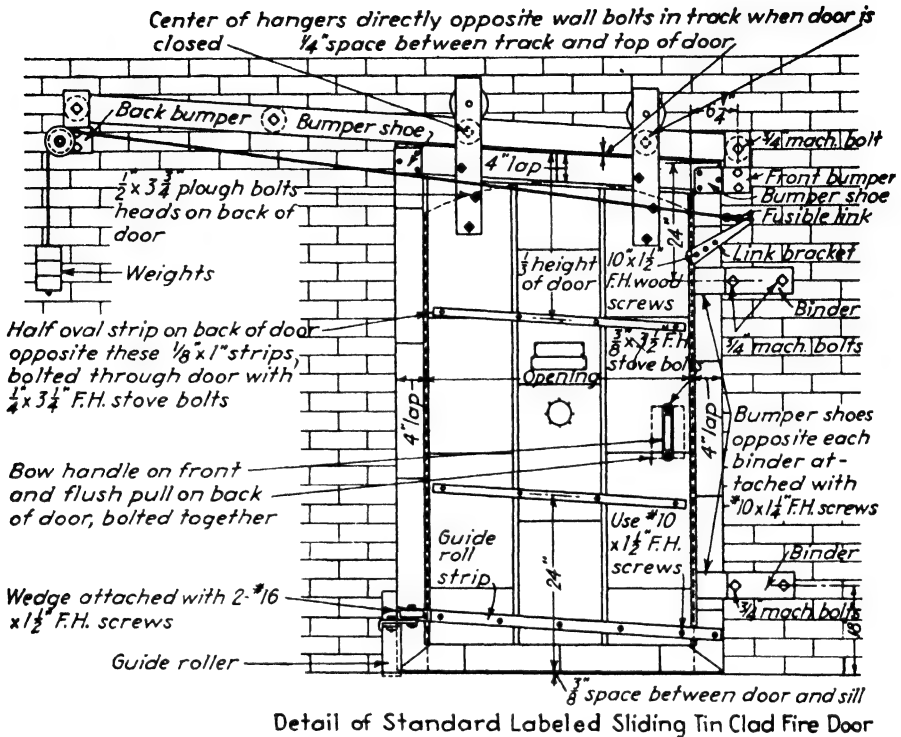


FIG. 141.—Sections through door frames.



Standard Labeled, Swinging, Tin Clad Fire Door and Channel Iron Frame

FIG. 142.—Tin clad doors.

solid-steel types. Kalamein and hollow-metal double-hung windows cost around \$35 each, and the rough wire glass that is generally used in them costs about \$10 additional. If clear wire glass is used, the glass cost would be \$20 to \$30, instead of \$10. The glass is generally estimated under the heading of Glazing.

Kalamein contractors commonly furnish all the kalamein doors and windows and the pressed-steel frames for the doors, and the tinclad fire doors. They always install the tinclad doors, but more often the regular carpenters on the job install the other items.

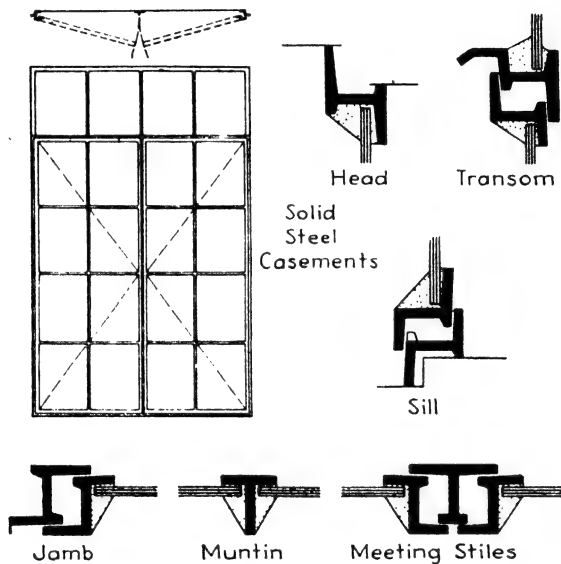


FIG. 143.—Steel casements.

Kalamein store-front construction is a specialty that is handled by separate subcontractors and is, therefore, placed in a division of the estimate by itself.

**Steel Sash.** Steel windows are popular for all types of buildings. They may be of the casement type, which swing on side hinges inward or outward; the pivoted or projected types, which are common in factories and public buildings; or the double-hung type. Many grades of these are made, and the estimator must take care to price the exact type and grade called for in the plans and specifications.

Steel sash is often given a separate division in the estimate, if many such items are required. Sometimes, however, they are specified under Masonry or Carpentry in the specifications and are then likely to be carried under one of those headings also in the estimate. If they are specified in the Iron division of the specifications, they are invariably

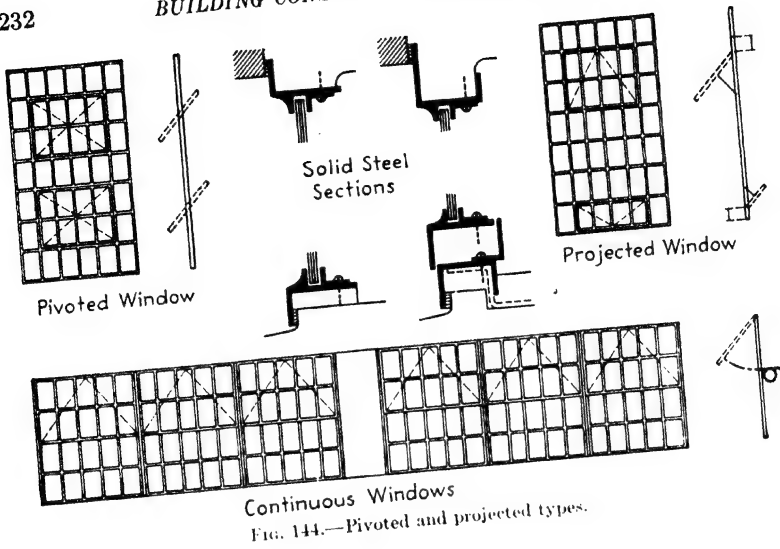


FIG. 145.—Rolling steel door, motor operated.

omitted by the iron contractors, because this is a special iron item with which they do not deal. Steel sash are stock items sold by the manu-

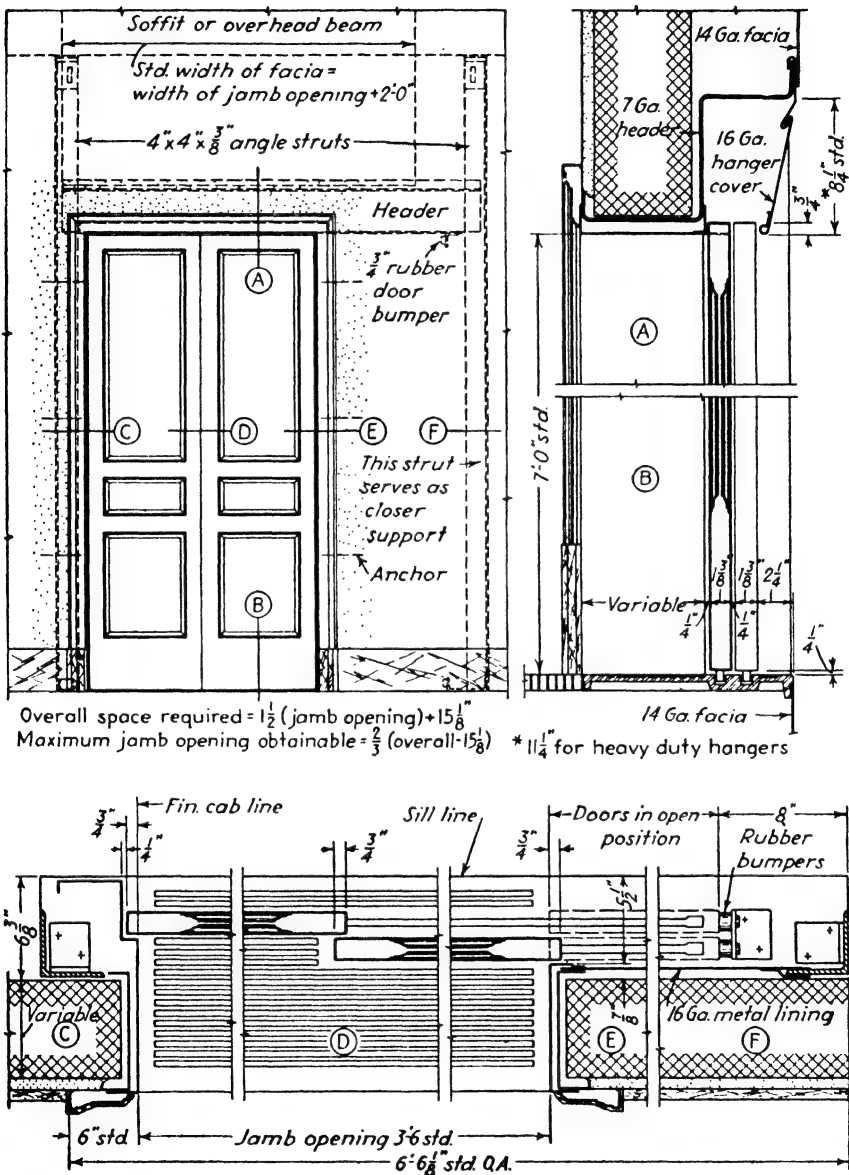


FIG. 146.—Hollow-metal elevator doors.

facturers directly to contractors. Some of these manufacturers quote on the installation of their windows, also.

**Rolling Steel Doors.** These doors coil up into head frames and are sold and installed by the manufacturers. Some of the features are patented. Both manually operated and motor-operated doors are obtainable.

**Store Fronts.** Store-front construction, consisting of the frames of show windows and the surrounding trim, etc., is usually made either of kalamein (metal on wood cores) or of solid-metal members. Many grades are made and many combinations of mouldings, etc. are possible. The work requires care in pricing. Generally, the mouldings are priced by the linear foot and an additional price per piece is applied for the corners, decorations, and special items. The flat surfaces of base under the show windows and the sign spaces over the windows are priced per square foot. Marble and other materials are often employed in store-front work, and these are estimated under the appropriate heading for the material involved.

Store-front show-window frames cost about \$50 for a small single store and about \$100 for a regulation double-window job in aluminum or copper kalamein. Bronze kalamein runs a little higher. Stainless-steel fronts and fronts of elaborate design, as well as hollow-metal or extruded or cast-metal fronts, cost thousands of dollars.

#### Exercises

1. What is kalamein work?
2. List the items on the house plans that would be included under fireproof doors and windows, giving the size of each item.
3. List the items on the plans in Chap. XXV that would be included under this heading.

## CHAPTER XXII

### TILE, TERRAZZO, AND MARBLE

Tile, terrazzo, and marble involve three separate lines of work. Some subcontractors handle two or all three of them; others, only one.

Plain floors and walls are measured by the square foot. Stair treads, door saddles, sills, and other such unit members are counted and priced per piece. Special features require careful analysis of the shopwork and field labor involved.

Bathroom wall fittings are generally included under the Tile heading. For estimating the cost of them the type, size, and number of each are listed.

Plain bathroom-type tile flooring costs the general contractor about 70¢ per square foot, and tile wainscoting about 90¢. Wall accessories cost \$1.00 to \$1.50, each. Medicine cabinets and other large fittings cost between \$6 and \$25 each for the usual sizes and types, but these are more often included under separate headings or under the heading, Carpentry.

Marble floor and wall covering runs about \$1.75 to \$3.00 per square foot. Matched or moulded marble may run to \$6.00 per square foot.

#### Exercises

1. What is terrazzo work?
2. Make an approximate estimate of the tilework shown on the house plans.
3. List the items shown on the plans in Chap. XXV that would be included under these headings.

## CHAPTER XXIII

### PAINTING, GLAZING, AND HARDWARE

Painting, glazing, and hardware constitute three lines, separate from one another. Painting and glazing are subcontracts. Hardware refers to the finishing hardware, such as lock sets, hinges, door checks, etc., and is a material item. The labor in connection with installing the hardware is listed under Finish Carpentry and other headings covering the doors and windows to which the hardware is applied. Some special items, like tinclad doors, steel sash, and overhead doors, are figured complete under their respective headings, including the hardware. Occasionally, a lump sum of money is specified to be allowed for the purchase of the finishing hardware and, in this case, the owner and the architect select the hardware after the construction work has started. The bill is sent to the contractor. If it costs more than the allowance, the contractor is paid the additional amount; if it costs less, he credits the owner with the saving.

**Painting.** Of the many kinds of paint that are made, the most common for exterior work is linseed-oil paint. This is used on interiors, also, especially for high-grade work, but water paints are more frequently used inside. Varnishes, enamels, and stains are needed, as well. All are generally measured in square feet of surface to be covered, and a price is applied to suit the material, number of coats, etc. Wall-papering also comes under the heading of Painting.

The painting subcontract generally takes in painting and papering done at the building only. However, owing to Union regulations especially, it is sometimes necessary to have the painting subcontractor include other items, besides. These include shop coats in some cases, priming in the shops or at the job, painting of structural steel, damp-proof painting, etc. It is part of the general contractor's estimator's duty to see that all painting is properly provided for under one or more divisions of the estimate.

Some painting estimators go over the plans and gauge the amount of labor involved in each room or floor and then add items in their estimate for the amount of white lead, oil, color, and other materials. Other painting estimators measure all the wall and ceiling areas in square feet and count the doors, windows, radiators, and other features with great care. Strange as it may seem, the first method seems to give as good

results as the second. However, only a man with thorough experience can use the shorter method. It would probably be good practice to adopt both methods on every job and check the resulting figures of one against the other.

Painting estimates vary greatly, probably because many painting estimators have careless methods or because they expect to attempt cheating on the job. It is well for the general contractor's estimator to check the lowest price carefully before using it in his summary.

Finished floors usually require protection. This may sometimes be accomplished by merely locking the doors of the finished rooms. In other cases, it is necessary to cover the floors with building paper or something better, and this represents expense that the estimator must provide for under General Job Expense, if it is not included under the headings of floor work or painting.

In checking the painting estimates, it may be found that some items have been omitted in them. Floor finishing, for example, may be included by some of the painting estimates and not by others. Papering or other treatments that do not involve paint may likewise be omitted in some of the estimates, or the bids may state that the special materials thus involved are to be furnished by others or are to cost not more than a certain amount.

Painting of new work generally involves three or more coats, and old surfaces, two coats. Each coat costs between 1¢ and 2½¢ per square foot, depending upon the quality of the material used and the workmanship called for, and also upon the amount of work involved, the kind of surface, the amount of scaffolding required, etc. If the work is out of the ordinary, these prices may be doubled. An average room costs about \$30 for painting the walls and calcimining the ceiling. A new store of average size may cost \$200 for the interior alone. A new building of good grade may cost about \$1,000 per story for the painting.

**Glazing.** Glazing covers an ever-widening field. Glass is now used not only in windows and doors, but in many other places, as well. Structural glass, which is rapidly coming into common use, offers all sorts of complications for the glazing estimator and for the general contractor's estimator. In this, as in all "modernistic" construction, the young estimator will do well to analyze all the possible incidental work and expense, as well as the actual glasswork. Any work out of the ordinary run of established materials and methods should be thought of in this way.

There are many types, thicknesses, and grades of glass. Large plate glass is measured very carefully, because of the rapid increase in square foot prices due to the special handling necessary for large pieces of such fragile material. Ordinary glass for windows and doors is counted

in number of pieces, or "lights," of the different sizes required. Mirrors are part of the glazing division. Leaded glass also is handled here, unless it is of a highly elaborate nature, in which case a separate special heading is usually set up in the estimate.

Union regulations generally require that all glazing shall be done at the job and that no windows or doors shall be sent to the job with the glass in them.

Large plate glass is usually not installed until the very last thing and, even then, it is immediately protected against being scratched or broken. This protection is to be provided for under the heading, General Job Expense.

Ordinary glass is subject to considerable breakage, which the contractor generally accepts rather than to stand the expense of protecting the glass. The judgment of the estimator must make allowance for this in the estimate. The amount to allow will depend upon the type of building, the type of neighborhood it is in, the time of year, and the amount of glass involved. Ordinary glass is installed before the end of the job if it is necessary to have this protection against the weather.

Small sizes of double-thick glass cost the general contractor about 30¢ per square foot, and plate glass, in small sizes, about 80¢ per square foot. The glass in a show window 8'0"  $\times$  10'0" may cost between \$80 and \$90. Pyramid glass, prism glass, and other types not in general use must be checked closely as the names are tricky and often misleading, and there are usually several thicknesses to choose from. Bent glass, leaded glass, and other special forms require careful analysis also. There are already several types of structural glass on the market and new ones may be expected. Some of these that do not cost much in themselves may involve a great amount of labor on the job, in order to satisfy the architect or the owner as to the effect they are looking for.

### Exercises

1. Make a list of the finishing hardware that would probably be required for the house.
2. Make a list of the glazing required for the plans shown in Chap. XXV.

## CHAPTER XXIV

### THE MECHANICAL TRADES

The term "mechanical trades" is generally applied to the piping, wiring, and machinery lines of work. On regular building work these include Plumbing, Heating, Electrical Work, and Elevator Work, which are described briefly in this chapter. On most jobs, these are all separate subcontracts. Some subcontractors, however, handle both plumbing and heating.

The mechanical trades, especially plumbing and heating, are often given out by the owner or the architect separately from the general contract for the construction work. In such cases, the general contractor may theoretically have nothing to do with these lines of work but, because the work is done in the building at the same time that the construction work is being done, conflict of interests may occur. Sometimes the general contractor is given jurisdiction over these separate contracts, even when they are thus separately awarded. Regardless of the specifications covering these lines, the general contractor is governed only by his own contract and the specifications that accompany his contract.

Excavating for the mechanical trades is an item that must always be checked by the general contractor's estimator. Sometimes these trades do all their own excavating and backfilling, but it is more customary for them to do only such excavating, backfilling, and street cutting and patching as is done outside the building.

Trenches for piping and other uses are frequently called for on plans or are specified. It is quite expensive to build these and to provide covers for them and sometimes for the waterproofing in connection with them. The trenches may be specified under Heating; the covers may be specified under Heating, Iron Work, or Concrete Work; the waterproofing may be under Heating, Concrete Work, Masonwork, or Roofing. The excavating for trenches may not be mentioned at all in the specifications. This will give the student an idea of the care that must be taken with the mechanical divisions of the specifications and with the estimates received from subcontractors in these lines. It is the responsibility of the general contractor's estimator to see that all these details are properly covered under appropriate headings and that none is estimated more than once.

The hot-water requirements of a building are supplied by a water heater and sometimes involve the use of a hot-water tank, besides.

Either or both of these may be specified under Heating or under Plumbing. They may even be specified under both headings. Some of the subcontractors in these lines will omit one or both of these items, thinking that the subcontractors in the other line will include them. Thus, apparently low bids will be received and it is the estimator's duty to straighten out the whole matter and to get sufficient bids in these lines in proper form to enable him to compare prices and arrive at an amount to be entered in his summary.

**Plumbing.** The plumbing subcontractor takes in the bathtubs, lavatories, and toilets in the bathrooms and toilet rooms, and the sinks and washtubs in the kitchens and cellars. Showers and shower curtains are part of the plumbing work, also, and sometimes the glass shower doors are included. Sheet lead, put under the tile floors of standing showers and in special watertight floor construction, is installed by plumbers and listed under Plumbing. Hot-water storage tanks and heaters come under Plumbing, except when they are an integral part of the main heating plant installed by the steamfitters. In any event, all the water supply and water connections are handled by the plumbers. All the water-supply and drainage lines, both inside the building and out to the mains in the street, are in this division. A plumbing contractor is required to have a city license.

Temporary water and toilet facilities for the job may involve the plumbing contractor. If, for example, a large amount of water is required for the construction work, it may prove advantageous to have the plumbers install iron pipes, instead of the workers' depending upon the more customary hose lines. This is especially true if the run to the supply source is long or if other conditions make the use of iron pipe worth while. If it is possible to make use of a sewer connection or other sewage-disposal connection, it is worth while on a large job to install regular toilets for the workmen, from the beginning of the job. After the toilet roughing is in, the building contractors generally do install such toilets, even having the plumbing contractor furnish second-hand toilets for the purpose. The plumbing contractor is generally called upon to provide a temporary water connection for the job use. The cost of all these items must be considered by the estimator and provided for in the Plumbing division or in the General Job Expense division of the estimate.

Sewers, catch basins, and manholes, if they are required, are generally specified under Plumbing. The plumbing contractors figuring the job, however, may or may not include all of these. Sometimes they include all but the manholes or all but the manholes and the covers for the catch basins. These are additional items for the general contractor's estimator to check carefully. Several manholes on a job may alone cost \$1,000.

Toilet and bathroom accessories, such as holders for soap and paper, mirrors, cabinets, etc., are sometimes specified under Plumbing. Regardless of this, many plumbing contractors choose to omit them, especially the cabinets, and may so state in their bids. Even if they should not state this in their bids, there would be a question as to whether they included these items. This would be especially so if, by chance, their bids read "For all the Plumbing work," instead of "For all the work noted in the Plumbing Section of the specifications."

The following list of definitions will assist the student in becoming familiar with some common plumbing terms and their meanings. They are from the New York building code and will therefore also introduce the student to the plumbing section of the law.

**branch.** That part of a plumbing system extending from the main to fixtures on not more than two consecutive floors.

**waste pipe.** Any pipe which receives the discharge of any fixture, except water closets, and conveys it to the house drain, soil, or waste stacks.

**soil pipe.** Any pipe which conveys to the house drain the discharge of water closets or other fixtures receiving fecal matter.

**vent pipe.** Any pipe provided to ventilate a house drainage system and to prevent trap siphonage and back pressure.

**stack.** A general term for any vertical line of soil, waste, or vent piping.

**house drain.** That part of the lowest piping of a house drainage system which receives the discharge from soil, waste, and other drainage pipes and conveys it by gravity to the house sewer. It ends at the outside of the front wall.

**private sewer.** A sewer not constructed by the City but complying with the Code of Ordinances.

**public sewer.** A sewer constructed or operated by the City.

**sanitary sewer.** A sewer designed or used to carry liquid or water-borne wastes from plumbing fixtures.

**storm sewer.** A sewer carrying rain or subsurface water.

**leader.** A general term for any vertical line of storm water piping.

**plumbing fixture.** A receptacle intended to receive and discharge water, liquid, or water-carried waste into a drainage system.

**Costs.** Regular plumbing fixtures cost the general contractor between \$40 and \$75 each, installed, with the branch piping and trimmings included. A building with many bathrooms may run between \$325 and \$375 per bathroom, complete. Small jobs of only a few fixtures cost much more per unit than the same fixtures would cost in a large job. Street sewer and water connections cost several hundred dollars each, with the incidental excavating and replacing of pavements.

**Heating.** The heating boiler, mains, returns, risers, radiators, and the incidental connections and valves, completely installed, make up the work of the heating subcontractor. Usually the pipe covering is

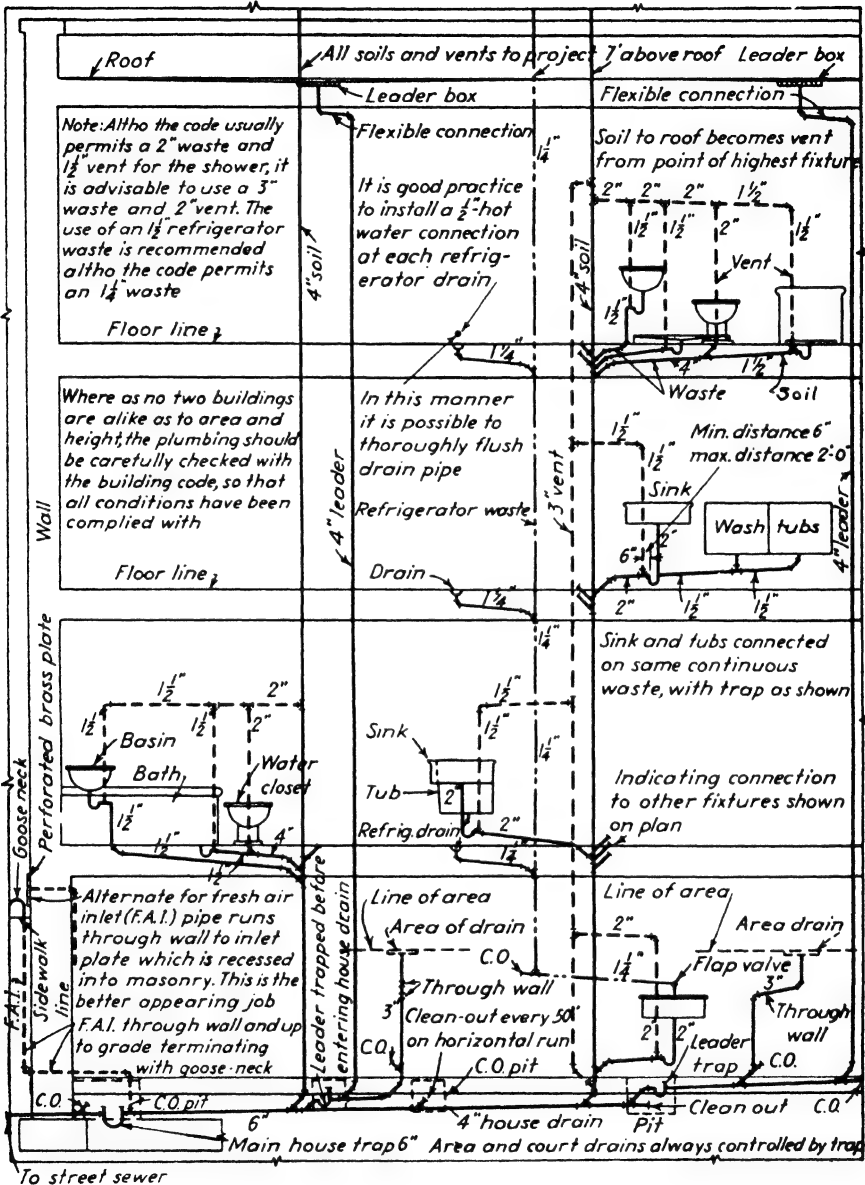


FIG. 147.—Plumbing piping.

included, and sometimes the oil burner, if one is required. On rare occasions, metal radiator enclosures are put in with the heating-work estimates, especially if they are for the recessed types of radiators. Sheet-metal ducts for air conditioning are sometimes included in the

heating contract and, at other times, with the sheet-metal contract. All these conditions must be watched carefully by the general contractor's estimator. Another question that comes up concerns water heaters attached to heating boilers. The estimator has to see that the plumbing and heating contractors provide for all the details required in this connection.

Heating systems are usually tested before they are accepted by the architect. As the testing involves the use of fuel, the estimator must see that the heating contractors figuring the job provide for this, or else he must make an entry here or under General Job Expense to cover the fuel. Likewise, the heating system may be placed in operation before the building is complete, in order to provide temporary heat. If possible, the estimator should have the heating contractor whose bid he plans to use quote also on furnishing the temporary fuel and the radiators and other material that may be required, and on maintaining this temporary heat for the job. If not, he will have to estimate it himself and make an entry here or in the General Job Expense division of the estimate, to cover the cost. In some sections, the steamfitters' union requires that a steamfitter's helper be kept on the job while temporary heat is being used.

Boiler pits and foundations and other masonwork in connection with heating plants are sometimes specified under Heating. Despite this, the heating contractors very seldom include this work. They may state in their bids that they include all the heating work, but, unless they have stated plainly that they included all the work that is noted in the heating division of the specifications, it would be questionable whether they had these items in their bids.

Ventilating and air-conditioning systems are often included with the heating work. In such cases, the estimator has to check with the sheet-metal estimates and the electrical estimates to see that all the required work in all three lines is included in the bids that he expects to use in his own summary. Much overlapping is possible. Occasionally, it is found that a few of the items involved are included by two different trades, such as fans in roof ventilators and the motors and controls for various fans, for example.

**Costs.** A steam-heating system costs between \$1.25 and \$1.50 per square foot of radiation. An ordinary house may have 500 feet of radiation. A six-story apartment house may involve \$10,000 for the heating work.

**Electrical Work.** All electric wiring done at the job for lighting, power-supply, and signal purposes comes under the heading of Electrical Work. Special machinery, such as elevator machines, pumps, fans, etc., are installed under other headings, but the electrical connections are

made by electricians and the cost for these connections is included under Electrical Work. Plain and special lighting outlets and reflectors, also, are always put under this heading, but the lighting fixtures are sometimes given a special heading. Electrical contractors are licensed by the city, and their work also comes under the inspection of the Board of Fire Underwriters organized by the fire insurance companies.

The electrical work in a building gives trouble to the general contractor's estimator mainly in regard to the machinery, fans, and other such equipment. Concerning the main wiring and the lighting system it is usually quite well established as to who furnishes what. Motors attached to fans and unit heaters, elevators, oil burners, and other motor-driven equipment are the things that must be watched. Unless these are very clearly specified, it is likely that neither the subcontractor furnishing the motor nor the electrical contractor will have included the control switches and connections at the motors. In preparing the estimate, it is necessary to see that one or the other does include the cost of this work. Heavy controls are expensive. Sometimes even the motors are left out, no one having included them. The sheet-metal contractor, for example, may take in a lot of exhaust fans and omit the motors for them. The electrical contractors may assume that these will come with the fans and so merely include wiring to the motors, even omitting the switches or other forms of controls.

Another item of electrical work that gives trouble is the temporary lighting or power that the job may require. Several of the subcontractors, requiring electric power to operate their equipment on the job, may specify in their bids that they assume the general contractor will furnish them with suitable current connections at proper locations in the building and at their shanties. The general contractor also may require power for equipment and nearly always has to provide temporary lighting in and about the job. Owing partly to regulations of the electrical unions (something of a "racket"), this temporary electric service has become an expensive item, sometimes to the extent that a job must employ one or more electricians on full time and with considerable overtime, merely to turn switches off and on morning and evening. This matter must be investigated for every job and properly provided for in the estimate. The electrical contractors fight shy of it, and usually the estimator has to use his own judgment in estimating the cost of installation, maintenance, overtime, and current consumption for the entire job requirements.

If the electrical contractor whose bid is to be used states that he includes only the work inside the building, or that extending to a point a few feet outside the building, the requirements of the job must be checked thoroughly, as there may be much outside work, such as poles, transformers, outside lighting, signal work, etc. Even if the electrical

utility company is to do some of the outside work--running the service to the building, furnishing transformers, etc.—it may be left to the general contractor to pay for this service.

Electrical work sometimes involves the construction of a transformer vault, machine foundations, supports for motors and fixtures, etc. Items like these require that the estimator look into the question as to who furnishes them, as they are not electrical work and, although they are specified in the electrical portion of the specifications, the subcontractor who states in his bid that he includes "all the electrical work" may take the stand that because these are not electrical work he does not include them, even though they may have been so designated in the specifications.

Lighting fixtures and other items of electrical equipment made in nonunion shops will almost surely cause trouble with the electricians working on the job. If items of this nature are to be supplied by the owner, it is the general contractor's place to notify him, through a statement in the bid for the job, that it is assumed any items to be thus furnished will be satisfactory in every way to the union requirements on the job. Some electrical unions insist upon removing all the wiring from lighting fixtures at the job because they were wired by nonunion shopmen or by members of another union, and then rewiring them at the job, all at the expense of somebody, who may be the general contractor.

Some types of lighting fixtures require considerable carpentry work to be done at the job to accommodate them—boxes for recessed lights, etc. This is usually done by the carpenters on the job and, unless such work is actually included in the electrical bids, it should be provided for under the heading, Carpentry.

If a sum of money is specified for the purchase of lighting fixtures or any other items on the job, it is the task of the estimator to ascertain just how the money is intended to apply, whether as the list price for such items or as the actual price to be paid out by the subcontractors. Otherwise, there may be a dispute when the items are being purchased.

**Costs.** Wiring and outlets cost between \$6 and \$8 per outlet for lighting work, if flexible cable is used, and between \$9 and \$12 per outlet if rigid pipe conduit is used. Ordinary lighting fixtures cost between \$1.50 and \$5.00 each, delivered, and about \$1.25 to \$1.50 each for installing. These are the prices that the general contractor is charged by the electrical subcontractor. Switches count as outlets. Letter boxes also come under the heading of electrical work, as they are commonly installed in connection with the bell system.

**Elevators.** The elevator always includes the entire mechanism of operating machinery, guide rails, cables, sheaves, cab, and signals. In the new-style automatic elevators, the shaft doors and the door-opening devices are included, as well. The electrical contractor runs his power

























|  |  |
|--|--|
|  Ceiling outlet                       |  Pull box                     |
|  Ceiling outlet (gas and electricity) |  Cable supporting box         |
|  Ceiling lamp receptacle              |  Meter                        |
|  Ceiling outlet for extensions        |  Transformer                  |
|  Ceiling fan outlet                   | — Branch circuit, Run concealed under floor above  |
|  Pull switch                          | -- Branch circuit, Run exposed   |
|  Drop cord                            | - - Branch circuit, Run concealed under floor  |
|  Wall bracket                         | — Feeder run concealed under floor above   |
|  Wall bracket (gas and electricity)   | -- Feeder run exposed  |
|  Wall outlet for extensions           | - - Feeder run concealed under floor   |
|  Wall fan outlet                      | ◇◇ Pole line   |
|  Wall lamp receptacle                 | □ Push button  |
|  Single convenience outlet            | □ Buzzer   |
|  Double convenience outlet            | □ Bell   |
|  Junction box                         |  Annunciator                  |
|  Exit light                           | ◀ Interior telephone   |
|  Floor outlet                         | ◀ Public telephone   |
| S <sup>1</sup> Local switch-Single pole  | ⌚ Clock (secondary)  |
| S <sup>2</sup> Local switch-Double pole  | ⌚ Clock (master)   |
| S <sup>3</sup> Local switch-3 way  | ⌚ Electric door opener   |
| S <sup>4</sup> Local switch-4 way  | ⌚ Local fire alarm gong  |
| S <sup>D</sup> Automatic door switch   | ⌚ City fire alarm station  |
| S <sup>K</sup> Key push button switch  | ⌚ Local fire alarm station   |
| S <sup>E</sup> Electrolier switch  |  Fire alarm central station |
| S <sup>P</sup> Push button switch and pilot  | ⌚ Nurse's signal plug  |
| S <sup>R</sup> Remote control push button switch   | ⌚ Maid's plug  |
| ⊙ Motor  | ◀ Horn outlet  |
|  Motor controller                   | ◀ District messenger call  |
| ■ Lighting panel   | ⌚ Watchman Station   |
| ▨ Power panel  | ⌚ Watchman central station detector  |
| ▨ Heating panel  |  |

FIG. 148.—Electric symbols used on plans.

line to the main switch in the elevator machine room and his lighting conduit to a point midway in the shaft.

A small elevator for passenger or freight use costs between \$2,500 and \$4,000. If the run is more than a few stories, the cost will increase, and if a high building is involved, the Building Code regulations and additional equipment will require special analysis. A six-story apartment-house elevator of the push-button type, including the shaft doors, etc., costs between \$4,500 and \$6,000, depending upon the make.

### Exercises

1. What is a plumbing soil line?
2. What is a waste line?
3. Draw six electrical symbols and state what each represents.
4. Make a list of the plumbing fixtures for the house, giving sizes where possible.
5. What other work in the house comes under the heading, Plumbing Work?
6. Make a list of the items in the house that would come under the heading, Heating Work.
7. Make a list of the plumbing requirements for the plans shown in Chap. XXV.
8. Make an approximate electrical estimate for the house.

## CHAPTER XXV

### ARE YOU AN ESTIMATOR?

This book was planned as a complete course in the work of the building contractor's estimator. If you have conscientiously studied everything in it, you are at least well on the way toward becoming an estimator. Practical experience is needed, however, just as in any other line of work. When a young man completes a course in chemistry or in bookkeeping, he may call himself a chemist or a bookkeeper; yet he is hardly qualified to take charge of a chemical laboratory or a bookkeeping department. In the same way, if you have completed the course outlined in this book, you may call yourself an estimator; but you should not expect to have full charge of preparing complete estimates until you have had considerable practical experience in building work.

This chapter contains a comprehensive examination, which will test your ability in estimating. If you have done the work called for in the book and receive a mark of 70% or better in this examination, you may feel sure of embarking on actual estimating work. If your mark is between 80% and 90%, you are better than the ordinary assistant in estimating. If you have really studied and worked satisfactorily during the whole course and earn between 90% and 100% in the examination, especially if you have reached a mark in this range in each of the two sections of the examination, you need have no hesitancy in calling yourself an estimator. Put it this way: You may classify yourself as a junior assistant in estimating if your final grade is between 70% and 80%, as a junior estimator if it is between 80% and 90%, and as an estimator if it is between 90% and 100%.

Before taking the second part of the examination, get as much practice as possible by borrowing several sets of plans and specifications from architects and builders and going through the entire procedure of making complete and accurate detailed estimates for all of them.

If your mark is over 90% in each of the two sections of the examination, take this book with you when you are seeking a position, and tell your prospective employer that you know everything in it. Carry along all your work sheets and your notebook for the entire course. If your interviewer is at all fair, he will have to admit that you have a good knowledge of the subject.

Before taking the examination, review all the chapters from the beginning. Chapter I calls your attention to the importance of the work of the estimator. It is work that requires patience and a methodical

way of doing things. It is not an undertaking for a careless person to attempt. Never vary your way of working in an attempt to please somebody who is looking for speed; you will not be thanked for it if there is a mistake in your work. If it is not prepared with your usual methodical care, there will be mistakes—always remember that. The estimator is usually the center of activity in a well-organized office, and this means that his work is the important work of the office, the work that means the difference between a profit or a loss on the job! Such work is not always properly valued by employers or by other members of a contracting organization; but the estimator finally learns that his reputation as a careful man is one of his main assets.

Chapters II, III, and IV deal with the people you will meet in building work. They are all interesting, and you will enjoy working with them. One striking characteristic of your work is the constant change that takes place, both in the kind and location of jobs and in the steady flow of different people—architects, engineers, inspectors, superintendents, draftsmen, foremen, subcontractors, material men, and workmen. Here is as great a variety as you could wish for; surely your work will never become monotonous. Learn your work well and really enjoy the company of other trained men, who, in turn, will enjoy working with you. Learn also to judge men, for you will find that not all are as sincere as you are. Keep your own character and reputation clean throughout all the trials and tribulations you encounter, however, for you will find truth in the statement made in Chap. IV—that character and reputation of the right sort contribute to your happiness.

Chapters V to VIII discuss plans and specifications and the legal side of building work. Plans and specifications have an important legal standing themselves, as they form the portion of the contract that explains just what is to be done. Everything shown on the plans or specified in the specifications is to be furnished or done by the contractor—the general conditions or the contract itself usually states the matter that way. Advise against signing any contract that you feel is not entirely clear and fair. Make your own subcontracts and purchase orders fair, and thus uphold your reputation. Bear in mind that the recommendations given in Chap. VI for a sort of estimating code are not actually in vogue. Perhaps the time will come when the building industry will develop and use certain standards of bidding that will eliminate some of the abuses of today. In the meantime, we shall have to make the best of the existing methods. Abide by the law in all things; remember that building codes are only schedules of minimum requirements and try to do better than is called for in these minimum requirements.

Chapters IX, X, and XI give a broad view of the preparation of estimates and of the general expense involved in the carrying on of building

operations. Some contractors make up estimates hastily, sometimes without the aid of an estimator trained as you have been. Such estimates can only be termed approximations, and, as is stated in Chap. IX, approximate estimates have a bad habit of not being correct and of bringing disappointment to those who use them. There is nothing more satisfying to a regular estimator than to see his carefully prepared estimate being used all through the life of a job and serving all purposes faithfully. Remember to picture in your mind, as you estimate, the actual working conditions, especially when you are gauging the unit prices to be applied. Remember to check all the large items and the unit prices you apply to them; they are the ones that will have the greatest effect on the total cost of the job. Do not let others influence your judgment too much. Look into every item thoroughly, yourself, so that you can be confident of your own judgment. Keep your estimates and quantity sheets in good order at all times; arrange them so that you or anybody else will be able to find any item quickly and to understand just what every item is for. Remember that work that is out of the ordinary in character is always more expensive to build than that with which every workman is familiar. Remember that work to be performed at a great distance from the center of business areas involves particular attention and care in arranging for workmen, deliveries of material, etc., and may require expensive transportation of both men and materials. Winter work usually means a whole list of items of extra expense.

Chapters XII to XIX give detail instruction for estimating the work that is usually done by the general contractor's own men. Only regular work has been considered, and you are therefore warned to watch out for unusual work or conditions and to study and analyze them to the best of your ability if you are to estimate on them. Excavating that you do not feel entirely confident in handling should be figured for you by subcontractors. Experienced estimators never hesitate to say that an excavating problem is too much for their firm to handle—if they really think such is the case. Building contractors should not be expected to be experts in difficult excavation or foundation work. Concrete work, likewise, may stump you, especially very complicated formwork. If you attempt to handle any complicated work in any line, measure and list the items with extra care and do not hesitate to put a much higher unit price on such work than you ordinarily would for the same work when it is not complicated. Your high price may prove to be low enough when the job is done, and you will not get any thanks for anything else.

Chapters XX to XXIV treat of the work usually done by subcontractors. Unless your firm has had experience in actually doing a number of jobs in these lines, it is always better to rely on dependable subcontractors than to attempt to do or even to estimate this work. The

mechanical trades, especially, are tricky, and estimators who have thrown in prices on them have often been sorry for having done so. Learn the ways of subcontractors. Learn to judge them. Beware of very young estimators who are sometimes used by subcontractors; they may not have had the training that you have and may lead both you and themselves into trouble. Do not measure plans or give figures for any subcontractors; let them get and be responsible for their own figures. Even if they forgive you for unwittingly misleading them, they will always feel that they have a moral hold on you and expect you somehow to fix things so they can regain what they lost or what they say that they lost. Be businesslike and perfectly honest with the subcontractors, but do not allow them to develop a personal friendship and then take advantage of such friendship. Be as impersonal as possible, and keep your reputation clean. Be loyal to the firm you work for. Work only for good people.

When you take this examination, do so with the knowledge that you will fool nobody more than yourself if you get a high mark without deserving it, by not making it a test that really proves to you yourself that you are an estimator. Fail in the test willingly, rather than start your career with a stain on your reputation!

### EXAMINATION

The examination is divided into two parts, the first covering Chaps. I to IX and the second, Chaps. X to XXIV. If it is desired, Part I may be given immediately after the classwork on Chaps. I to IX has been completed. This is recommended especially when these chapters form the work of the first year in a two-year course.

The students are to do one of the exercises from each of the groups given in the chapters. These are to be selected by the instructor or the school administration and announced or issued when the examination begins.

In addition to the exercises taken from the chapter groups, the following questions and problems are also to be included. To conserve time, note that in all problems involving the measuring of plans, only the names of the items and the dimensions of them are required, no time being taken for making any extensions of figures. The numbers noted in parentheses after some of the questions indicate the number of words used by the average student properly to answer the questions in the time allowed.

### PART I

#### 20 Questions and Problems at 5% Each

1-9. These are exercises taken from the lists at the end of Chaps. I to IX, and will be announced by the instructor.

10. Building estimating requires a working knowledge of all phases of building work. Why? (50 to 75 words.)
11. The estimator, in a well-organized office, is usually the center of activity in the office. Why? (50 to 75 words.)
12. Before the work at the job can begin, the estimator makes up the various schedules, etc. What are these, and how are they used? (30 to 50 words.)
13. When the job gets under way, the estimator gradually relinquishes hold. How should he turn the work over to the superintendent? (40 to 60 words.)
14. The construction of a building involves many kinds of administrative and technical skills. Name 10 positions of administrative and technical skill that are found in the actual construction of a building.
15. How does a contractor go about getting plans for new jobs that are to be estimated? (40 to 60 words.)
16. What information should a good estimate contain? (50 to 75 words.)
17. On a regular building job costing about \$200,000 there are usually many items of general job expense. Make a list of these for such a job and show after each the approximate cost that might be involved.
18. Imagine that the job in Prob. 17 is actually under way. Make a daily report such as the job superintendent would send to his home office for a day when the job is well organized and about half completed. Include remarks regarding a dispute between the superintendent and the architect's inspector about the quality of some material.
19. Make a diagram and describe the relationship between the men usually concerned with building work, similar to the treatment of this topic in Chap. II, Construction Relations. (60 to 80 words and diagram.)
20. Write a descriptive composition of 100 to 150 words on Plan Reading, using the plans on the following pages to illustrate the points brought out in your composition.

## PART II

- 1-15. These are exercises taken from Chaps. X to XXIV, and will be announced by the instructor. (15 at 3% each.)
16. List every tenth term from the Index, to a total of 20 terms. Every student is to start with a different term. One student starts with the first term in the Index, the next student with the second term, etc., and then each tenth term thereafter. State the meaning and use of each term clearly in 20 to 30 words. Sketches will be accepted in lieu of 10 to 20 of the words. (20 terms at 1% each.)
17. Make a complete detailed estimate for the plans given on the following pages, omitting the extensions of quantities, to save time, but including roughly approximate totals for the purpose of pricing. Extend and total all money amounts. Use assumed subcontractors' figures for the plumbing, heating, and elevator work, only. (35%.)

BANK AND OFFICE BUILDING  
OUTLINE SPECIFICATIONS

**GENERAL.** The intention and meaning of these specifications and the accompanying drawings is to provide and secure a new complete building 30'0" × 50'0" containing cellar, three floors, and mezzanine. The work includes the structure and the plumbing, heating, and elevator work. The electric work, signals, and electric fixtures are not included in this contract and will be done by others under a separate contract.

The standard form of the "General Conditions of the Contract," copyrighted 1937, as established by the American Institute of Architects, is hereby included in

and made a part of these specifications, whether or not attached hereto. A copy of these "General Conditions" is on file at the office of the architect where same may be inspected by contractors figuring on the work.

The reference to "Supervision" in the Standard Form shall mean that the Contractor shall provide a superintendent having at least twenty years' experience on building construction (at least ten years as Superintendent), a job engineer having at least ten years' experience on building construction work (at least five years as Engineer), a job clerk having at least eight years' experience on building construction work (at least five years as Chief Job Clerk) and as many assistants as required to properly carry on and expedite the work. The three "key" men shall be on duty at the job at least forty hours per week from the start to the final completion and acceptance and shall not be replaced without the written consent of the Owner and the Architect.

The Contractor shall provide a job office, not less than 10 ft.  $\times$  16 ft., with not less than two rooms and fitted with electric lights, telephone, desks, chairs, plan tables, racks, files, typewriter, engineers' instruments, etc., and shall maintain same in good order solely for office purposes.

**EXCAVATING.** Do all excavating of every description and whatever substance encountered. Should the excavation through accident or otherwise be taken out below the levels shown on the drawings the contractor shall fill in the resulting excess excavation with 1:2:4 stone or gravel concrete at no extra cost.

**CONCRETE WORK.** All materials shall be new, clean and of substantial quality and quantity. Cement shall be Portland conforming to the latest standard specifications of the American Society for Testing Materials. Sand shall be coarse and washed. The coarse aggregate for all concrete below the finish first floor level shall be washed gravel or crushed stone uniformly graded from  $\frac{1}{4}$ " to 1". The coarse aggregate above the first floor shall be clean steam cinders.

Provide substantial forms, oiled for all exposed concrete surfaces, for all the concrete work including the footings.

All concrete below the finish first floor level shall be 1:2:4 stone or gravel concrete. Provide 4"  $\times$  4"  $\times$  #6 wire mesh reinforcing in the first floor slab. Set and grout all anchor bolts and steel bearing plates. Grout to be 1:3.

All concrete above the first floor shall be 1:2:5 cinder concrete. Provide 4"  $\times$  4"  $\times$  #8 wire mesh reinforcing in all the second floor and hall and toilet floor slabs. Provide standard steel soffit clips on all steel beams. Slabs are 4" thick.

Fill the iron stair treads with 1:3 mortar, troweled smooth, with light wire mesh embedded in it. Treat the intermediate landings likewise.

Run a 6" coved cement base throughout the second floor and in all the halls, toilets and slop sink closets, except in the cellar.

Lay a 5" slab throughout the cellar and in the elevator pit and apply a 1" finish of 1:3 on it and troweled to a smooth and perfectly level finish.

Patch the sidewalk neatly, adjoining the building, with concrete and finish and mark off to match the present work.

Lay 1:3 cement finish, troweled smooth and perfectly level, on the slabs throughout the second floor and in all the toilets and the slop sink closets, and in all the halls of the second and third floors and roof bulkhead.

**MASONWORK.** All materials shall be new, clean and of substantial quality and quantity. Cement shall be Portland conforming to the latest specifications of the Society for Testing Materials. Lime shall be an approved hydrated lime. Sand shall be fine sand suitable for brick masonry. Brick shall be hard burned red common brick of uniform size and with true shape. The two walls returning from the fronts shall be faced for a distance back of 10 feet with smooth face brick matching in color the limestone. Terra cotta blocks shall be Natco or equal. All mortar shall

be 1:1:6 and all joints shall be full shoved joints not more than  $\frac{1}{2}$ " thick and shall be uniform and straight.

All piers shall be well bonded within themselves and to the adjoining walls.

All cellar partitions shall be of smooth finish terra cotta blocks. All other terra cotta blocks shall be scored to receive plaster, those at the shafts being smooth on the shaft side.

Clean and point all exposed interior and exterior brick and terra cotta with muriatic acid and water.

Install terra cotta copings on the two rear walls, except over the face brick. Install 12"  $\times$  16" terra cotta flue lining.

Set, bed and grout all bearing plates, window frames, beam anchors, brackets, bolts, flashings, etc.

Provide cast iron cleanout door and frame and terra cotta smoke pipe thimble in the boiler room.

Install approved reinforced gypsum structural plank flooring on the mezzanine floor and on the mezzanine stair landing. This shall be  $2\frac{1}{2}$ " thick and provided with rabbeted edges to fit between the structural steel angles.

**STONEWORK.** All granite shall be Deer Isle granite. This consists of the base course, on the two street fronts, extending 2" below the sidewalk grade. It shall have "eight-point" finish. The pier bases shall be in one piece 6" thick. Also included are the two entrance steps which shall be in one piece each, 8" thick, 14" wide, with wash on top.

All limestone shall be standard buff genuine Indiana limestone. This consists of the wall facings as shown and also the copings and return copings, the window sills, and the chimney cap. All exposed surfaces shall be smooth planed. The name: FIRST NATIONAL BANK, shall be neatly and accurately carved in the stone over the bank entrance as shown. The general ashlar shall be installed in proper bonding with the brick backing and to comply with all local building ordinances. All bond stones shall be 4" thicker than the normal thickness of the facing. Greater dimensions shall be provided where required for jambs, reveals, lintels, architraves and sills. No stone shall have a bed less than 4".

All exterior marble shall be White Alabama marble  $1\frac{1}{4}$ " thick with polished finish.

Submit shop drawings showing the bedding, jointing and anchoring of all stonework. The entire two street fronts and the exposed portions of all the openings in them shall be covered with stone. Provide openings for the cellar vents and for the plumbing fresh air inlet. Provide all anchors required. Set all stone and parge back of all stone with nonstaining cement mortar. Rake out all joints  $\frac{3}{4}$ " deep and fill with pointing mortar colored to match the stone. Clean down all stonework upon completion of the job. Protect all stone with wood covering.

**STEEL AND IRON.** All steelwork shall conform to the latest edition of the standard specifications for structural steel for buildings as adopted by the American Institute of Steel Construction. All steel shall have a shop coat of red lead and linseed oil paint before it is delivered to the job. All shopwork shall be riveted and all field connections bolted with the threads upset.

All ironwork shall be substantial, neat and perfect for the purposes intended. All joints shall be smooth and close. All material shall have a shop coat of red lead and linseed oil paint before being delivered to the job.

The ironwork includes standard stairs and railings of office building type. The treads are to be pan type for cement fill and the flight from the main hall is to have a decorative cast-iron newel about 4"  $\times$  4" with a bronze cap, decorative balusters, and this flight is to be set to receive  $1\frac{1}{8}$ " marble treads placed on top of the cement

fill. Also included are the standard cast-iron fluted saddles for the elevator shaft door openings and bronze fluted saddle for the door between the entrance hall and the bank. Provide also a simple railing with moulded cap along the edge of the mezzanine, and a pair of flush checkered steel trap doors and frame in the sidewalk.

Submit complete shop and setting drawings for all the steel and ironwork.

Include two 12"  $\times$  31# sheave beams in the elevator machine room. Include substantial framing for support of elevator bulkhead, and iron stair to machine room. Include standard bearing plates and anchors for all steel beams and columns.

**CARPENTRY.** All materials shall be new, clean and of substantial quality and quantity. All floor beams shall be Dense Select Structural Douglas Fir or Dense Structural Southern Pine, officially grade-marked. Roof beams shall be No. 1 Common Douglas Fir. Finish flooring for third floor office space shall be No. 2 plain red oak,  $1\frac{3}{4}$ "  $\times$  2 $\frac{1}{4}$ " face, D&M and end matched, underlaid with asphalt saturated felt. Subflooring and roof sheathing shall be No. 2 common pine or fir,  $\frac{7}{8}$ "  $\times$  6" T&G. Cross-bridging shall be 1"  $\times$  3". Fur all exterior walls with 1"  $\times$  2" pine furring strips 16" on centers, except in cellar and shafts.

Provide anchors for every fourth beam end. Provide roof blocking and cant strips as required. Provide curbs for the skylights and vent. Install 2"  $\times$  6" roof beams over the stair bulkhead, resting on a 2"  $\times$  4" plate anchored to the block walls. Provide 1 $\frac{1}{2}$ " round hardwood handrails on the iron stair railings. Provide 1"  $\times$  6" white pine or poplar baseboard and two mouldings, in the workroom and mezzanine portions of the bank and in the third floor office space.

All the doors indicated to be of wood shall be of No. 1 Door Stock White Pine or Ponderosa Pine,  $1\frac{3}{4}$ " thick. Provide cylinder locks, ball-bearing butts, liquid door closers, and stops with hooks for all office doors, with six keys for each door and two master keys. Provide bit key locks and plain butts for all the other wood doors, with six keys for each door and four master keys.

Provide double-hung sash and frames for all windows on the second and third floors, and stools, aprons and casings. The sash shall be  $1\frac{3}{4}$ " thick white pine. Stools shall be  $1\frac{1}{8}$ " thick, aprons  $\frac{3}{4}$ "  $\times$  4 $\frac{1}{4}$ " housed into stools, and casings  $\frac{3}{4}$ "  $\times$  4 $\frac{1}{4}$ " moulded and provided with backbands.

Provide a standard steel sash, stationary type, in the stairway bulkhead, anchored to the blocks. Caulk all windows.

Provide a paper holder, a coat hook, a glass lavatory shelf and a chrome-framed 18"  $\times$  20" mirror in each toilet room.

**HOLLOW METAL AND KALAMEIN.** Provide pressed steel frames for all wood and metal doors, except the elevator doors, which are specified under "Elevator Work."

Provide standard hollow metal bronze doors for the two openings leading from the halls to the bank spaces. These shall be one-panel doors and shall be provided with cylinder locks having solid bronze knobs and escutcheons. They shall also have solid bronze ball-bearing butts and burglarproof dead locks with solid bronze escutcheons, and heavy liquid door closers.

Provide standard kalamein doors where indicated, one-panel type, fitted with butts and bit-key locks. Provide burglarproof dead locks also on the two doors to storage spaces A and B and also to the storage room C. The two roof doors shall be flush construction on the outside. Provide six keys for each door, and three master keys for the bit-key locks only.

**ARCHITECTURAL METAL.** This division of the work shall be done by a subcontractor approved by the Architect and the Owner. To meet approval the subcontractor must have a record of many satisfactory jobs of high grade and must have a well-equipped shop.

The work includes all the door and window frames on the two street fronts of the first story and mezzanine and the two sets of entrance doors, together with all the fittings and hardware for these openings. It also includes the grilles on these openings and the frames, sash and grilles for the cellar vent openings, and the perforated cover on the plumbing fresh-air inlet.

All the construction of this work shall be of heavy type and of the highest grade of workmanship. All exposed parts shall be polished stainless steel. Complete shop drawings shall be submitted to the Architect and shall be revised until they meet his entire approval.

The door saddles may be either aluminum or stainless steel abrasive saddles, eight inches wide, and provided with Rixson door hinges. Heavy cylinder locks with stainless steel escutcheons and handles shall be provided, and the bank entrance shall also have a burglarproof mortise dead bolt. The lock bolts shall have stainless steel ends.

Complete inside trim for all the openings is to be included also as no other finish will be provided except the marble stools in the window openings.

**CABINETWORK.** This division of the work shall be done by a subcontractor approved by the Architect and the Owner. To meet approval the subcontractor must have a record of many satisfactory jobs of high grade and must have a well-equipped shop.

The work includes the partition along the edge of the mezzanine floor, the partition and door below the mezzanine, the complete bank screen with counter, drawers and door, the railing at the manager's office, the bank entrance vestibule and vestibule doors, and the hall entrance vestibule and vestibule doors, together with all fittings and hardware.

All this work must be of the highest type "Cabinetwork." Complete shop drawings shall be submitted to the Architect and shall be revised until they meet his entire approval.

The partitions, bank screen, railing and the roof of the bank vestibule shall be formed of 2" X 3" framing and covered on both sides with solid stiles and rails and veneered paneling. The doors and the drawers shall be of veneered wood. All the other wood shall be solid. All exposed wood throughout shall be selected and matched American Walnut and shall be given a high-grade "furniture" finish.

The bank screen shall be 5'0" high. The customers' shelf shall be 1 $\frac{1}{8}$ " thick and extend through to the back of the screen. The portion above the customers' shelf shall consist of five posts supporting four pieces of  $\frac{1}{2}$ " thick plate glass. The top edges of the glass shall be polished and each piece shall have a pass opening formed in it. The return portion of the bank screen shall be similar but with ground plate glass.

The counter top shall be 1 $\frac{1}{8}$ " thick. A continuous foot rest shall be provided under the counter, and eight drawers shall be installed to occupy the entire length immediately below the counter top. The counter top shall be level and 36" above the floor. The customers' counter shall be 39" above the floor. The railing shall be 39" high with a flat top 5" wide. The drawers shall have roller or suspension guides.

Provide complete hardware for all the doors, with aluminum or chrome-plated brass exposed parts. Include Rixson floor hinges for the active doors. Include cylinder locks with electric openers, and  $\frac{3}{16}$ " thick ground plate glass, for the two doors in the bank screen and partition. Include push plates, pulls and  $\frac{3}{16}$ " clear plate glass for the four vestibule doors. Include  $\frac{3}{16}$ " ground plate glass for the partition below the mezzanine and  $\frac{3}{16}$ " clear plate glass for the partition on the mezzanine and for the transom sash above the hall vestibule doors.

**PLASTERING.** There will be no lathing or plastering required in the cellar, nor in the shafts, nor on the ceiling under the mezzanine. All iron stair soffits will be exposed except the one in the entrance hall. This one shall be lathed and plastered.

Apply 3# metal lath on all the wood furring strips on the exterior walls throughout. Apply a coat of cement mortar on this lath for the marble wainscoting in the entrance hall and in the bank public space and manager's office. Apply three coats of lime plaster on all other portions of this metal lath. Finish the walls in the toilet rooms with Keene's cement plaster and finish the walls elsewhere with a hard white plaster of Paris finish.

Apply two coats of plaster, finished hard white, on all the terra cotta partitions and in the stairway bulkhead, and also on the ceilings in the toilets and in the halls of the mezzanine and second floors, and on the mezzanine ceiling.

Apply 3# metal lath and three coats of plaster, finished hard white, on the ceiling areas in the balance of the second and third floors and in the stairway bulkhead.

Construct hung ceilings over the high portion of the bank space and also in the entrance hall and the entrance hall vestibule. This construction shall meet all the requirements of the local building ordinances. The hangers and runners shall be of substantial iron members well anchored to the concrete construction. Lath shall be 3# metal lath. Plaster shall be three coats with hard white finish. The ceiling in the bank shall be run level directly under the floor beams of the second floor. The ceiling in the entrance hall shall be 12'0" above the floor. The ceiling in the vestibule shall be as high as possible. Close in the vertical spaces above the hall and vestibule ceilings with similar construction.

Run a 12" girth moulded plaster cornice around all four sides of the bank space, and close in the vertical space back of the cornice along the mezzanine side. Run a 4" girth moulded plaster cornice in the entrance hall, with a double face portion across the stair soffit and around the stair well to form a ceiling panel.

**INTERIOR MARBLE.** Install Gray Tennessee marble wainscoting on the two street walls in the public space and manager's office in the bank, and also on the exterior wall at the back of the manager's office. This shall extend up to the window sill level and shall consist of a base 1¼" thick and 9" high, matched flush panels ⅞" thick and a moulded cap 2" × 2". Install 1⅛" thick stools in the window openings, extending to ½" beyond the cap and provided with moulded exposed edges. Install a similar stool in the window below the mezzanine, with an apron ¾" × 4" under it.

Install Gray Tennessee marble on the walls of the entrance hall and vestibule, full height, and extending up the stairway to the level of the mezzanine floor, and extending on the wall under the stairway down to the level of the first floor. This shall consist of a base 9" high and 1¼" thick, matched flush panels ⅞" thick and 24" high, a band 1⅛" × 3", and matched panels above ⅞" thick.

Install Gray Tennessee marble treads 1⅛" thick on the stair from the entrance hall to the mezzanine.

Submit complete drawings to the Architect for approval before starting any work.

Clean and polish all marble upon completion of job.

**TERRAZZO.** Lay a 1" mortar underbed and a ½" thick terrazzo floor in the entrance hall and vestibule. Provide white brass strips with ¼" wide tops to form a modernistic design as will be detailed. The terrazzo will be formed with marble and granite chips of three colors as will be selected by the Architect. The terrazzo shall be machine rubbed and grouted, the grouting coat removed by machine, and the floor then fine-stoned and washed.

**GLASS.** Glaze the exterior windows of the first and mezzanine floors with ¼" thick polished plate glass of the highest quality. Glaze the windows of the second

and third floors with double-thick A-quality sheet glass. Glaze the steel sash in the stairway bulkhead with  $\frac{1}{4}$ " rough wire glass. Glaze the six office doors with  $\frac{3}{16}$ " thick Syenite glass. The balance of the glass is specified under other headings.

All glass shall be bedded in putty and be back-puttied. Face puttying shall be run smooth and true. Putty shall be of an approved brand and special putty shall be used in all the metal windows.

**ROOFING AND SHEET METAL.** Lay composition roofing on the main roof, composed of one layer of roofing paper nailed to the roof sheathing, four layers of roofing felt each embedded in a full coat of asphalt roofing cement, and a surfacing of 400 lb. of washed gravel or 300 lb. of crushed slag per 100 sq. ft.

Install copper flashings and counterflashings at all vertical surfaces, extending up at least 12" and built into brick joints at the top 1 $\frac{1}{2}$ ".

Cover the stairway and elevator bulkhead roofs with building paper and four layers of roofing felt each embedded in a full coat of asphalt roofing cement, and a surfacing of Ruberoid roofing lapped 17" and turned down over the edges of the roofs. Cover the outside of the terra cotta block walls of the stairway bulkhead with a coat of creosote oil and a coat of fibrous asphalt mastic troweled smooth.

Dampproof the outside of the elevator pit walls and the outside of the cellar walls up to the grade level by applying a priming coat of creosote oil and a mop coat of hot coal tar pitch.

Install Barrett-Holt Type 1-LG leader connections.

Furnish a ten-year written guarantee, signed by the roofing contractor and the general contractor, covering all roofing and flashings.

Provide a copper, wind-driven vent, with 24" throat, of a good standard manufacture and approved by the Architect, over the toilet vent shaft.

Provide copper skylights, with ridge ventilators, over the top floor toilet rooms, glazed with rough wire glass.

Provide Fire Underwriters' type louvered vents and frames for the other toilet rooms, 24" wide  $\times$  24" high.

Flash the wall above the skylights and vent with copper flashing and counter-flashing extending up to and under the coping.

**PAINTING.** Calcimine all plaster ceilings and cornices throughout.

Apply three coats of linseed oil paint on the ceiling under the mezzanine.

Apply four coats of linseed oil paint on all plastered wall surfaces on the first and mezzanine floors.

Touch up all bare spots of exposed steel and iron with red lead and apply two coats of linseed oil paint to all the exposed steel and iron.

Apply two coats of linseed oil paint on all plaster wall surfaces on the second and third floors and stair bulkhead, and to the wood baseboard.

Apply one coat of cement-lime paint on all exterior wall surfaces in the cellar and the entire height of the elevator and vent shafts, extending this 12" on to the adjoining surfaces also.

Apply one coat of cold-water paint on all interior wall and partition surfaces in the cellar and on all wall and partition surfaces in the elevator and vent shafts, in addition to the painting already specified.

Apply one coat of gloss enamel on all wall surfaces in the toilets (except in cellar), slop sink closets, and for a height of five feet in the halls and stairways of the second and third floors, in addition to the painting already specified.

Apply three coats of linseed oil paint to all the pressed-steel door frames, all the kalamein doors, all the metal louvers, and to all the wood doors and windows except those covered under "Cabinetwork."

Apply one coat of combination filler and finish to the wood flooring on the second and third floors.

All surfaces shall be perfectly dry and ready for painting before any painting is started. The painting subcontractor will be held responsible for inspecting and testing the surfaces and producing a guaranteed job.

All materials shall be fresh and of approved makes. Each paragraph above calling for paint shall provide for a different color, at the option of the Architect. Each coat of paint shall be of a slightly different tone so as to provide for easy inspection as to the surfaces being fully covered by each coat. Each coat shall be approved by the Architect before the next coat is started. The painting contractor shall cover the floors throughout the building with building paper and when the work is completed and ready for final inspection he shall remove this paper and all surplus materials and tools, etc.

**PLUMBING.** Install a complete system of plumbing, including water and sewer connections under the street, and all in full accordance with the local building regulations and ordinances. This includes brass hot and cold water piping, 3" cast-iron leaders with screw joints, and fixtures of Standard Sanitary Mfg. Co. make with chrome-plated brass trimmings and exposed branches. Run water lines to the heating boiler, which will be provided also for water heating. Provide a forty-gallon tank for hot water. Cover all hot and cold water lines and the tank with approved covering. Provide a water meter and water connection of ample size. Provide a control valve on each water line in the cellar and a control valve under each fixture.

**HEATING.** Install a complete two-pipe gravity oil-fired steam heating system guaranteed to heat the entire building to 70° when the outside temperature is 10° below zero, and also to supply hot water during winter and summer.

All materials shall be new, of substantial quality and of approved standard makes. The boiler shall be designed for a safe steam working pressure of 15 lb. gauge and a hydrostatic test pressure of 60 lb. per sq. in. and shall be complete with all fittings, trimmings and tools, and connected to the flue with an iron smoke pipe.

Steam and return piping shall be standard-weight wrought steel. Fittings shall be standard-weight cast-iron screwed steam pattern fittings. Valves shall be single wedge standard-weight 125# W.S.P. screwed pattern, brass bodied, brass mounted, bronze stem.

Provide ceiling type radiators in the cellar. Provide a convector with finished enclosure under each window throughout the building and one in each vestibule. The sizes of all radiators, convectors and piping shall be such as will produce an even heating distribution.

The oil burner shall be a Petro or General Electric outfit complete in every respect, with a 450 gal. tank.

Provide a Minneapolis-Honeywell thermostat control system with the thermostat located in the bank manager's office.

Cover all steam and return piping with approved covering. Install floor flanges around piping running through floors. Provide heating risers in the toilets, with covering and canvas outer covering on the lower four feet in each toilet.

Provide chrome-plated radiator inlet valves. Provide a chrome-plated brass-body thermostatic radiator trap of the multiple diaphragm type at the return end of each radiator. Provide all other required or recommended valves, traps, strainers, specialties, fittings, supplies, etc. to produce a noiseless and thoroughly efficient installation throughout.

Furnish a written guarantee, signed by the heating contractor and the general contractor, covering all of this work for a period of one year.

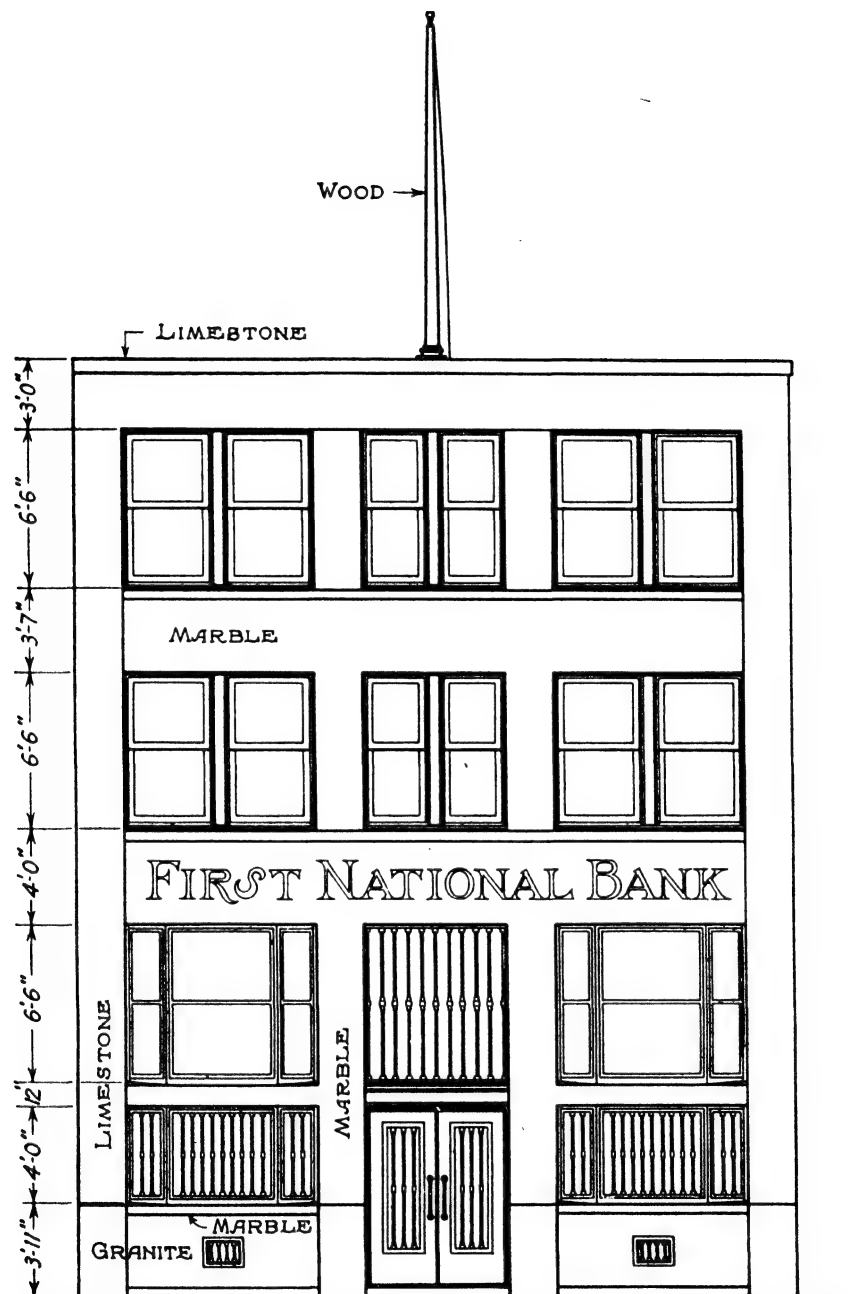
**ELEVATOR.** Install a complete passenger-elevator outfit and shaft doors and frames. This work shall be done by Otis, Westinghouse or an approved equal manufacturer. The elevator shall be as large as the shaft dimensions permit and all the work shall meet the requirements of the local building ordinances.

The car shall serve all five landings and have a speed of approximately 75 FPM. It shall be of the automatic push-button type with all safety devices and floor leveling automatic mechanism and door interlocks. All the materials shall be new and of the latest types. The work includes a car with rubber-tile flooring and decorated baked-enamel steel enclosure, overhead machine, cables, guides, controls, counterweights, limit switches, motor, light, buffers, lubricators, safety and governor, wiring in hatchway, switches, and all other items necessary for proper and complete installation. Also included are hollow steel shaft doors with baked enamel finish and pressed-steel frames, car gate, door closers and interlocks, push-button controls and car-in-use indicators.

The electrical contractor will furnish an outlet near the mid-point of the shaft for lighting and a power feeder with a knife switch in the machine room. The elevator contractor shall do all other wiring and electrical work.

Provide a written guarantee covering the entire installation for one year and providing for free maintenance and repairs and parts during that period. If any repair or maintenance work or service is found necessary it shall be done promptly and at any time of day or night to suit the Owner's convenience.

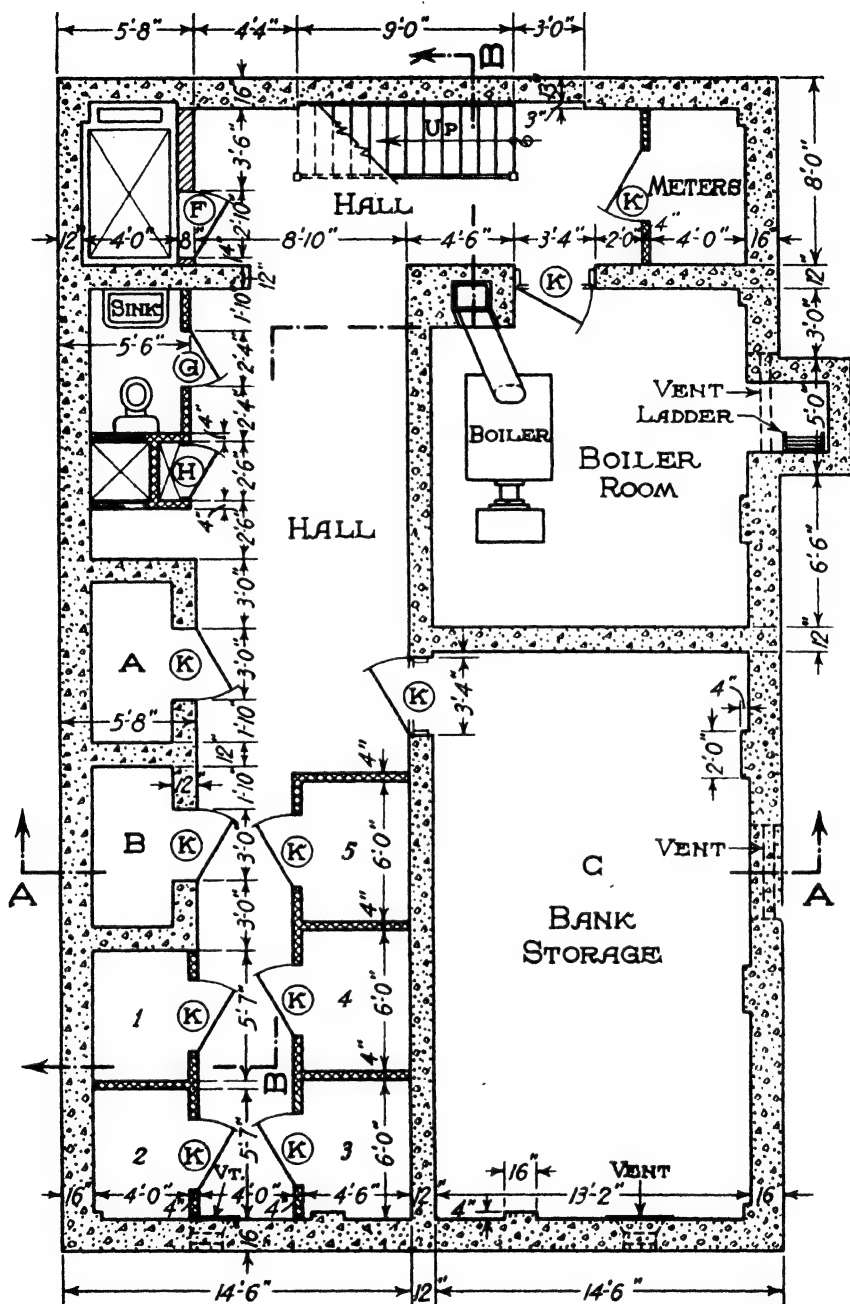
**ELECTRIC.** The electrical work, including bank and building signals and lighting fixtures, will be done by others under a separate contract. The general contractor and his subcontractors shall cooperate with the electrical contractor in every reasonable way.



— FRONT ELEVATION —

— SCALE :  $\frac{1}{8}" = 1'0"$  —

FIG. 149.

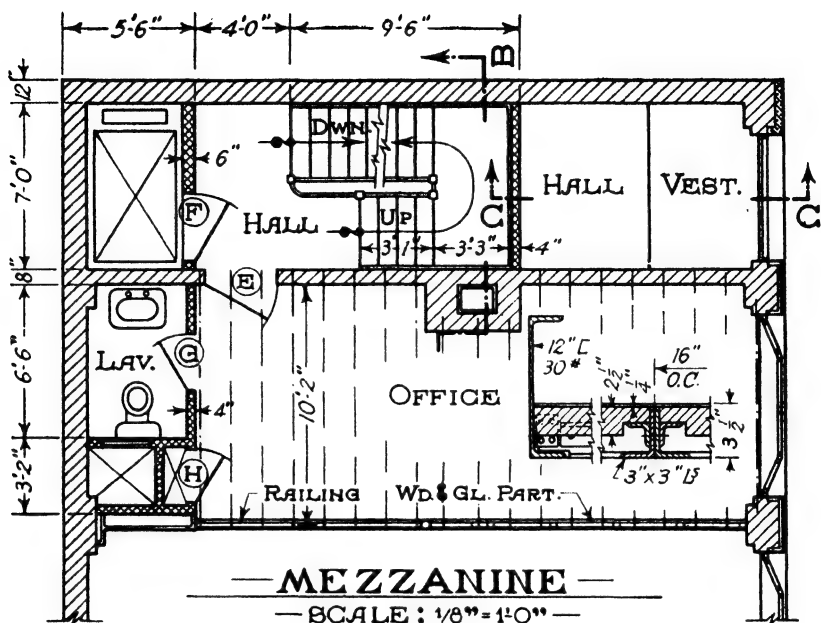


# **— BASEMENT PLAN —**

— SCALE: 1/8" = 1'-0" —

FIG. 150.





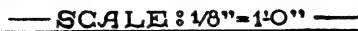
SCALE, ALL PLANS: 1/8" = 1 FOOT

KEY: [Pattern] = CONC. [Pattern] = BRICK [Pattern] = T.C.

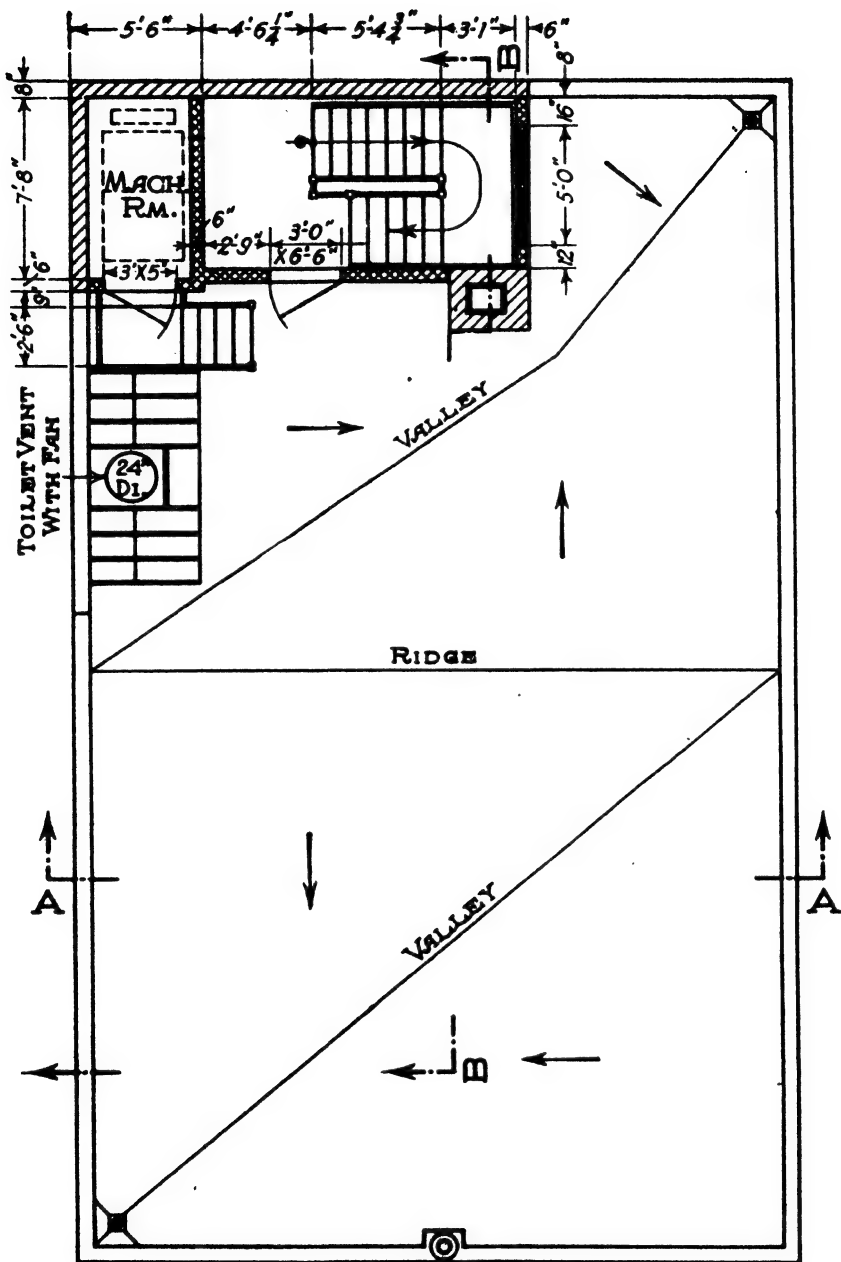
DOOR SCHEDULE:

| TYPE | SIZE        | MATERIAL       | REMARKS            |
|------|-------------|----------------|--------------------|
| A    | 6-0 x 15-11 | BRONZE & GLASS | SEE DETAIL         |
| B    | 5-8 x 7-6   | WOOD & GLASS   | WOOD FRAME         |
| C    | 5-4 x 15-0  | BRONZE & GLASS | SEE DETAIL         |
| D    | 5-4 x 7-6   | WOOD & GLASS   | WOOD FRAME         |
| E    | 3-0 x 6-8   | HOLLOW METAL   | STEEL FRAME        |
| F    | 2-10 x 6-10 | HOLLOW METAL   | STEEL FRAME        |
| G    | 2-4 x 6-8   | WOOD           | LOUVRES BOTT. PAN. |
| H    | 2-4 x 6-8   | KALAMEIN       | STEEL FRAME        |
| J    | 2-6 x 7-0   | WOOD & GLASS   | WOOD FRAME         |
| K    | 3-0 x 7-0   | KALAMEIN       | STEEL FRAME        |
| L    | 2-8 x 6-8   | WOOD           | STEEL FRAME        |
| M    | 3-0 x 7-0   | WOOD & GLASS   | STEEL FRAME        |
| N    | 3-0 x 6-6   | FLUSH KAL.     | STEEL FRAME        |
| P    | 3-0 x 5-0   | FLUSH KAL.     | STEEL FRAME        |

FIG. 152.



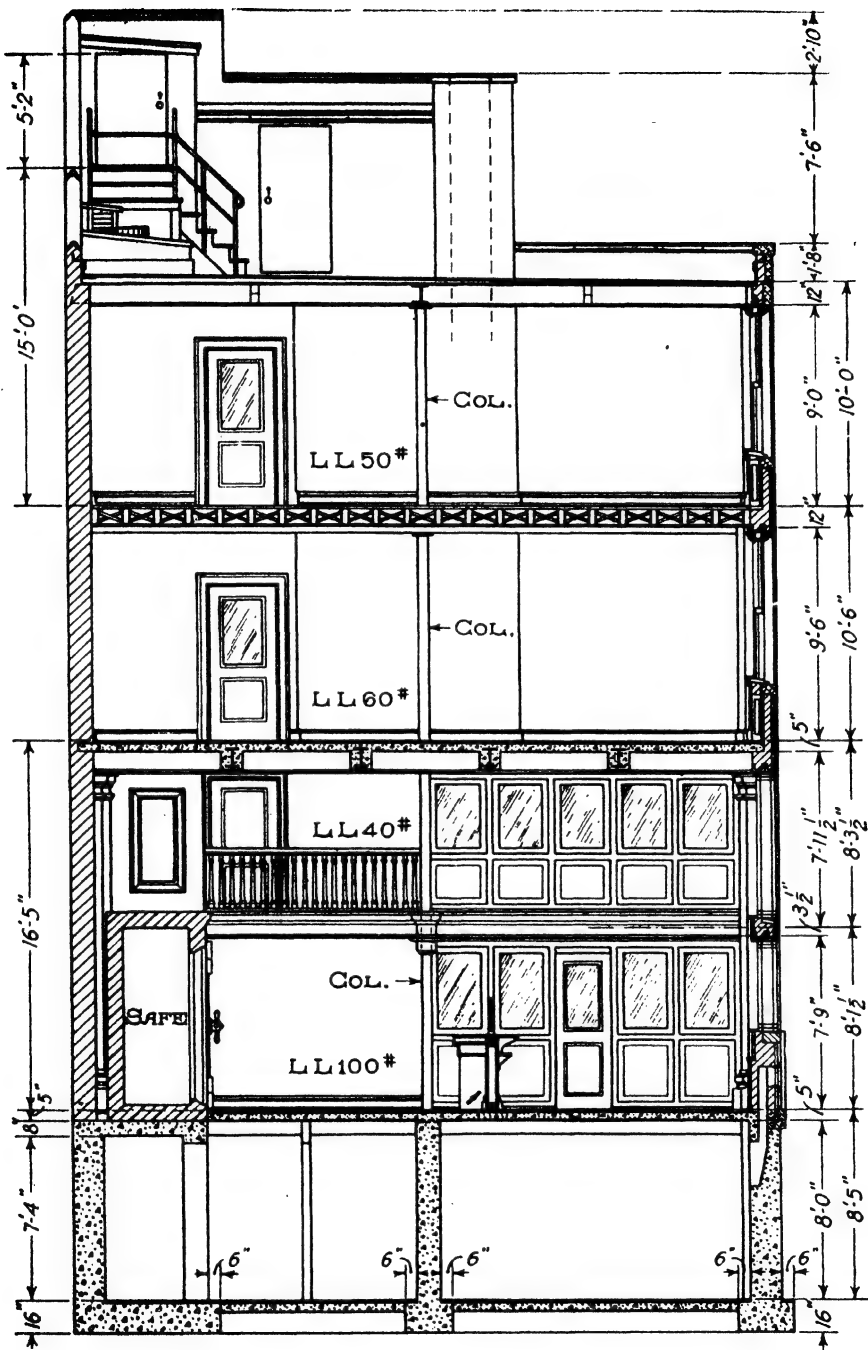
265



# — ROOF PLAN —

— SCALE: 1/8" = 1'-0" —

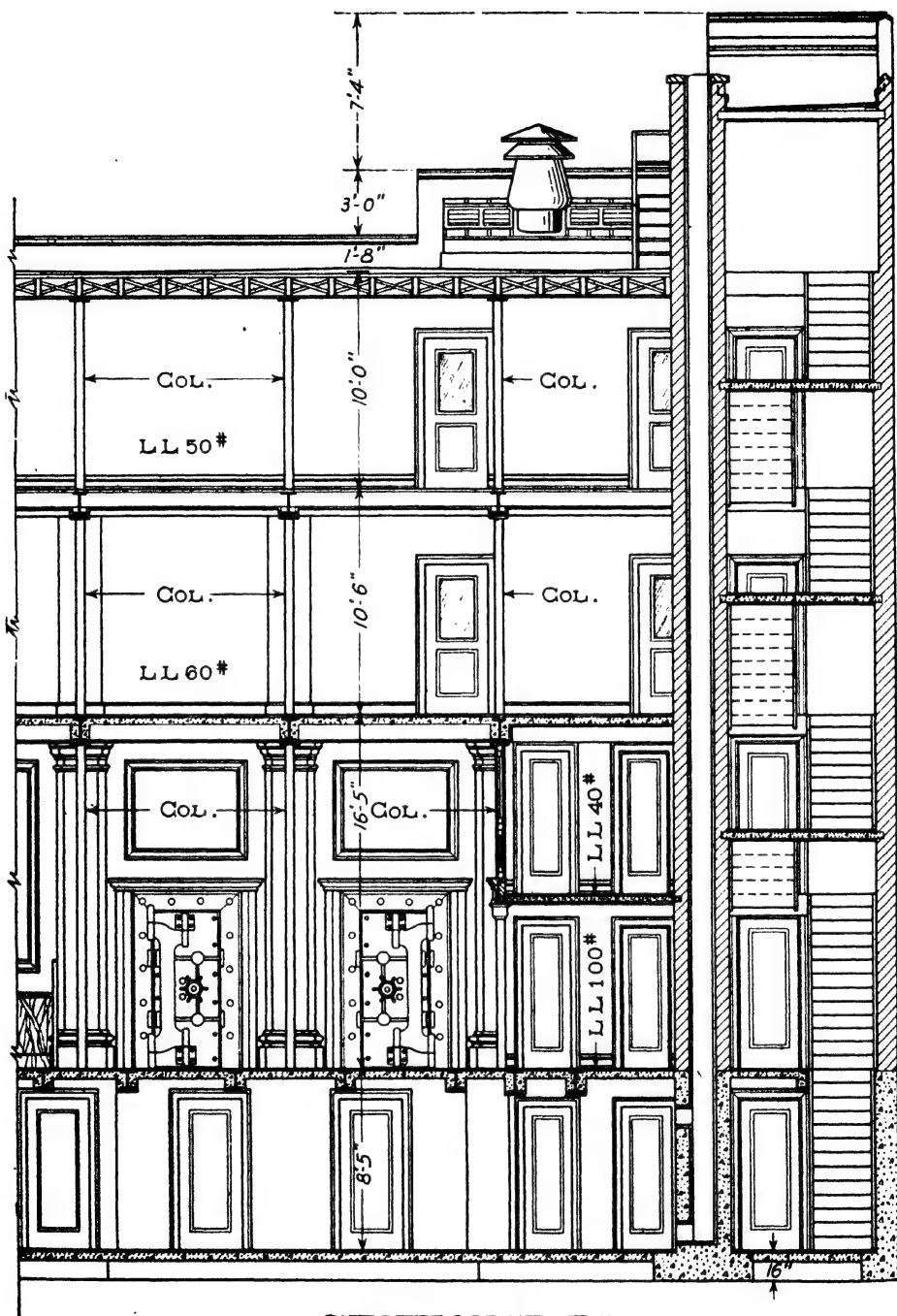
FIG. 154.



# SECTION "A-A"

SCALE: 1/8" = 1'-0"

FIG. 155.



# SECTION "B-B"

SCALE: 1/8" = 1'-0"

FIG. 156.

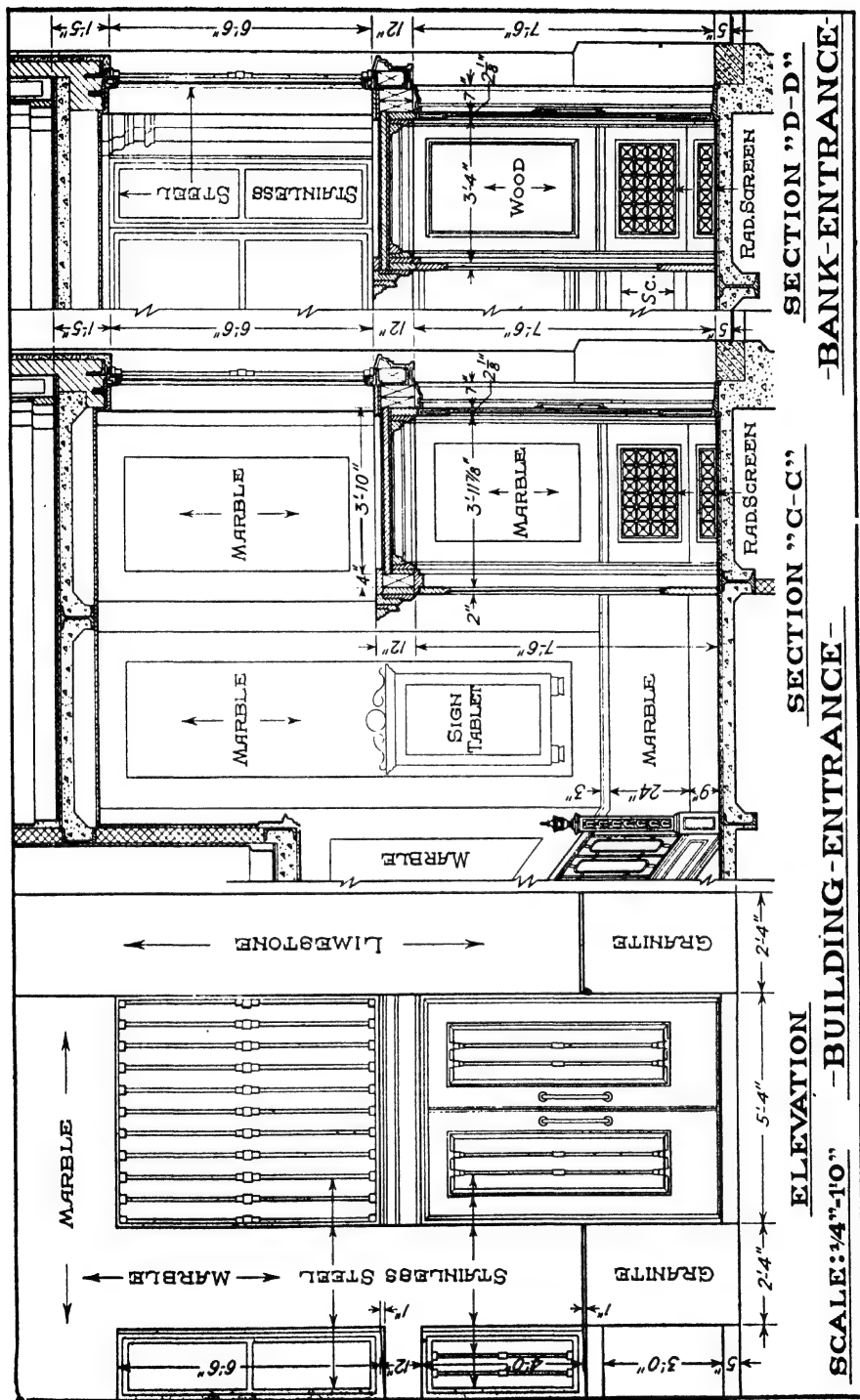
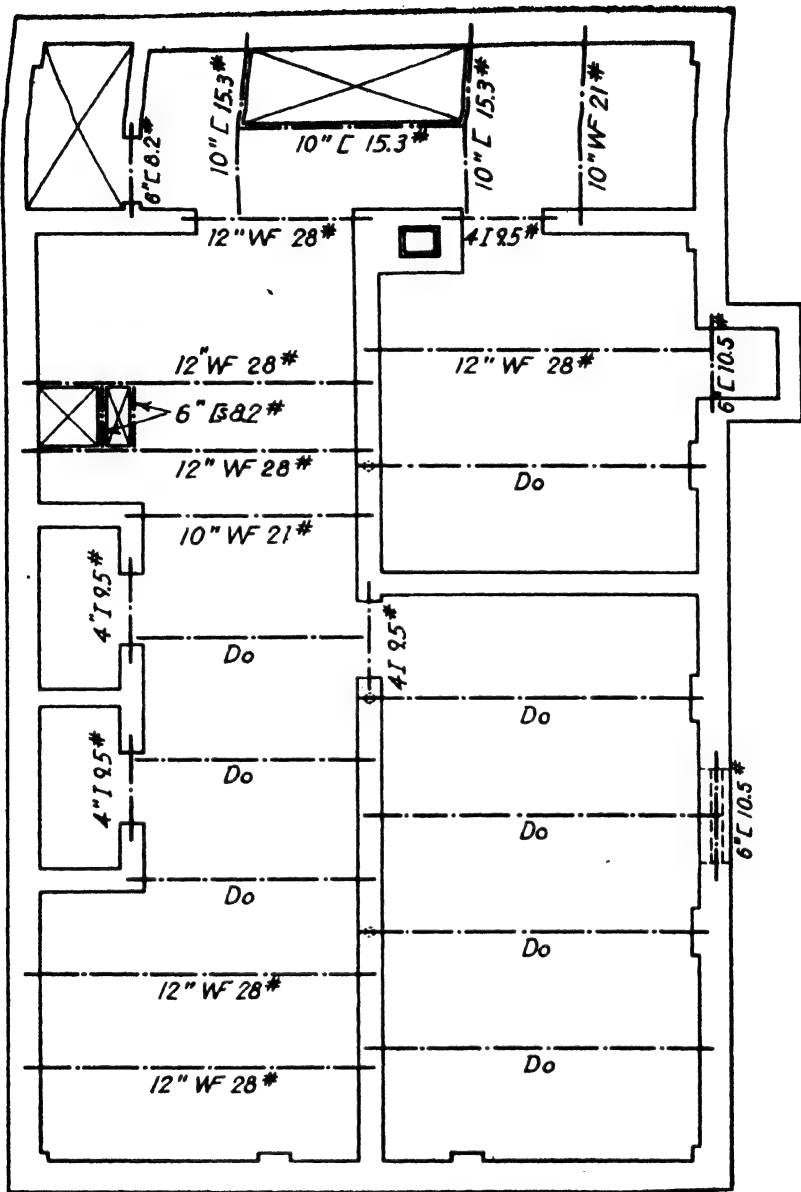


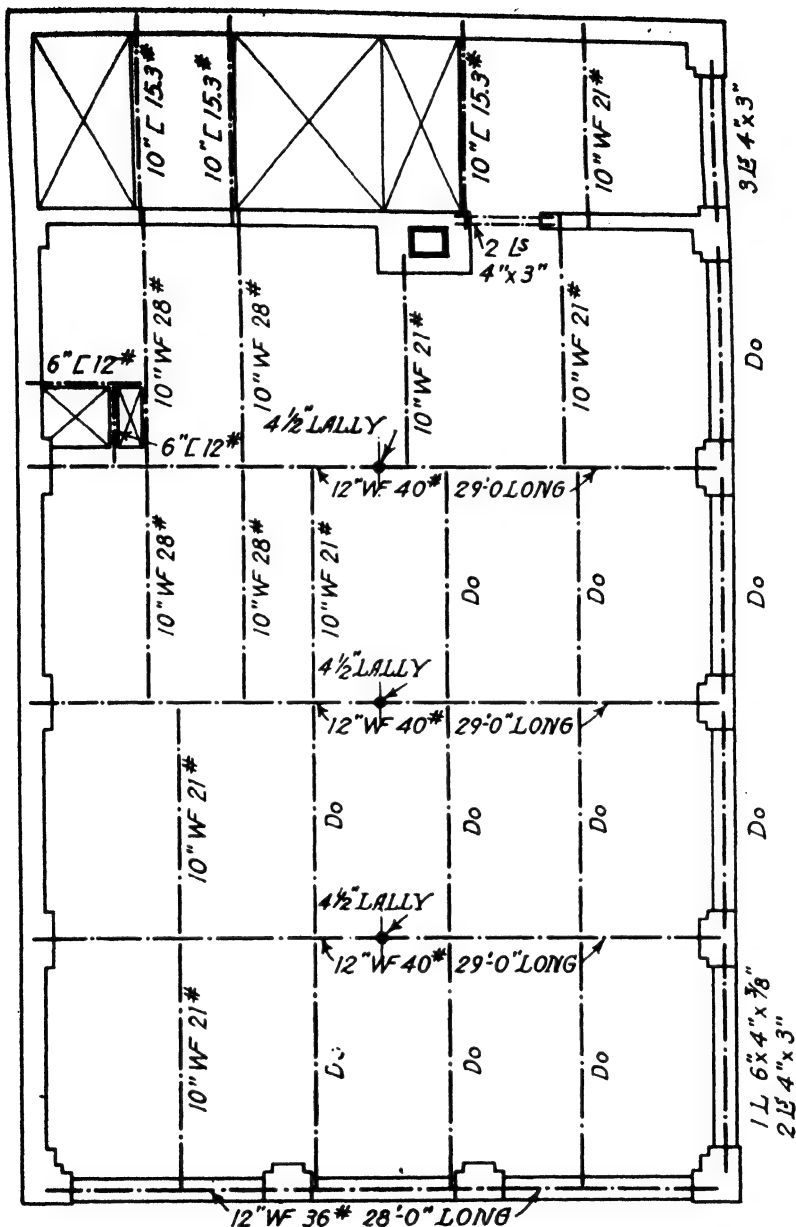
FIG. 157.



— FIRST FLOOR FRAMING —

— SCALE:  $\frac{1}{8}'' = 1'-0''$  —

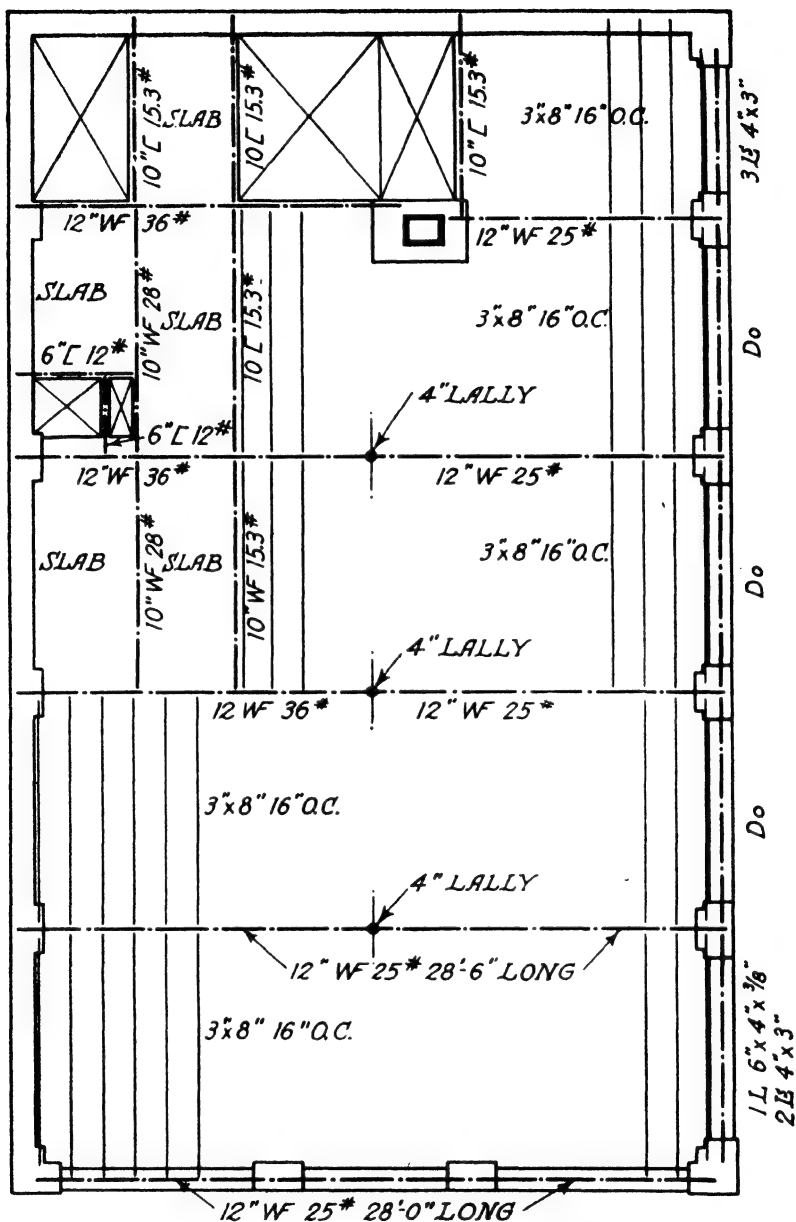
FIG. 158.



**— SECOND FLOOR FRAMING —**

— SCALE: 1/8"=1'-0" —

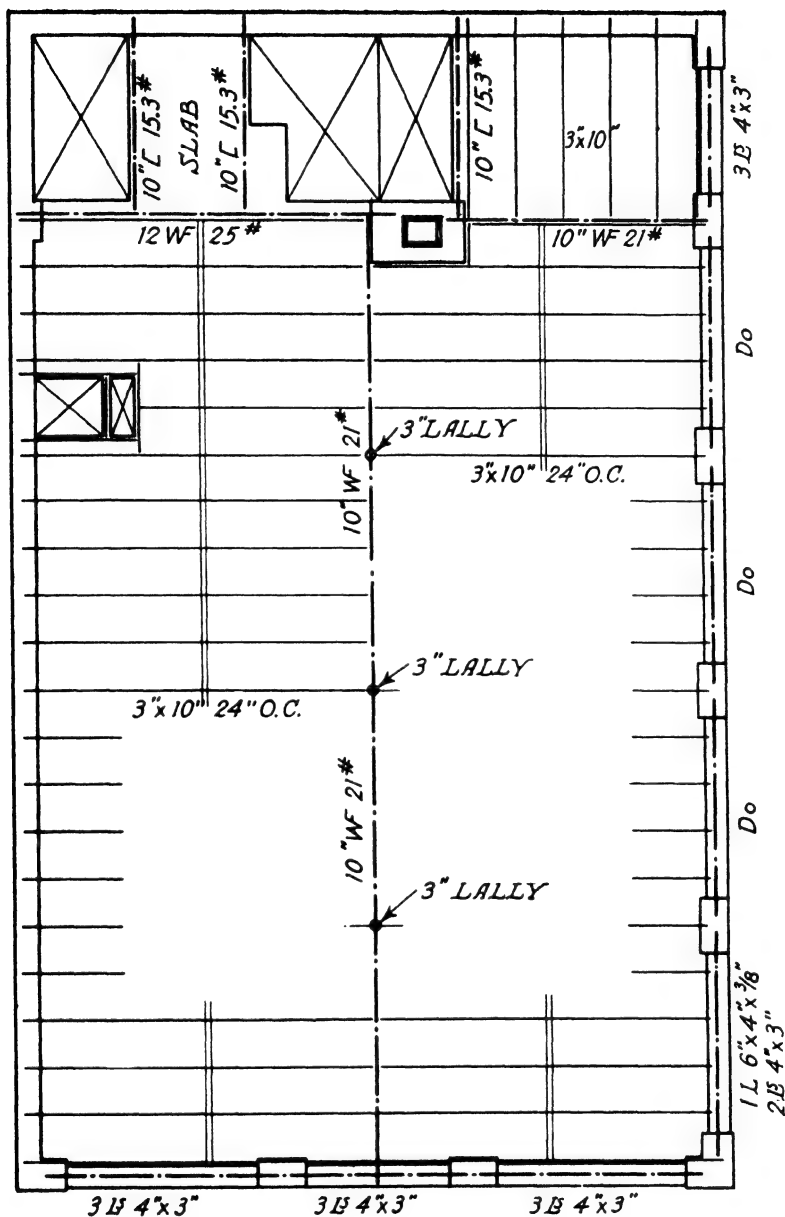
FIG. 159.



### THIRD FLOOR FRAMING

SCALE: 1/8" = 1'-0"

FIG. 180.



## — ROOF FRAMING —

— SCALE: 1/8" = 1'-0" —

FIG. 161.



## INDEX

### A

Accessories, bathroom, 241  
 Accounting department, 84  
 Acid, muriatic, 128, 135  
 Aggregates, 105, 108  
 Agitators, concrete, 105  
 Agreements, 54-60  
 Air conditioning, 242  
 American bond, 143  
 Analyzing plans, 69  
 Anchors, carpentry, 161-167  
     in concrete, 103, 124  
 Angle of repose, 96  
 Angles, steel, 213  
 Apron, window, 199  
 Apron wall, 51  
 Arbitration, 57, 59  
 Arches, brick, 149  
     concrete, 113-127  
 Architect, decisions, 9, 71  
     functions, 4, 9  
     license, 10  
     office, 9-11  
     peculiarities, 56, 71, 91, 173, 211  
     practice, 12  
     specifications, 10-15, 26, 65, 252  
     superintendent, 6, 13, 14  
 Architectural plans, 26-49, 261-269  
 Architectural terra cotta, 136-140  
 Areaway, 37  
 Ashlar, 226  
 Asphalt, roofing, 219  
 Astragal, 198, 201  
 Average concrete, 52

### B

Backband, 196, 197, 202  
 Backfilling, 98  
 Back-up blocks, 133  
 Balloon framing, 158  
 Bar spacers and bolsters, 123  
 Bars, reinforcing, 106, 109, 118, 123

Baseboard, 196  
 Basketweave brickwork, 142  
 Bathroom accessories, 241  
 Batter boards, 88  
 Beam and girder forms, 103  
 Beam hangers and boxes, 164  
 Beams, ceiling, 160, 203, 204  
     concrete, 113-120, 126  
     steel, 28, 30, 210-213, 270-273  
     wood, 155-168, 272, 273  
 Bearing partition, 165-167  
 Beech flooring, 207  
 Bid summary, 91, 92  
 Bids from subcontractors, 216, 243, 244  
 Birch doors, 196  
 Birch flooring, 207  
 Birch lumber, 156  
 Blocking, wood, 204, 205  
 Blueprints, 26  
 Bluestone, 226  
 Board measure, 68, 79, 157  
 Boards, 155  
 Bolsters, bar, 123  
 Bolts, anchor, 103, 124, 161-167  
 Bond, brick, 141-144, 147, 148  
 Bonded cement finish, 180  
 Bonds, surety, 89  
 Bowstring truss, 174  
 Box gutter, 221  
 Braced frame, 158-160  
 Braces, corner, 160, 164, 169  
 Branch, in plumbing work, 241  
 Breast timbers, 96  
 Brick, common, 128, 130, 134, 141-144  
     enameled, 145-148  
     face, 128, 130, 135, 141-144  
 Brick veneer, 151  
 Bridging, carpentry, 158, 164, 166  
 Bridle irons, 164  
 Brown coat, plaster, 192  
 Buck, rough, 196  
 Budget estimates, 61  
 Builder, 17

Building code, 6, 50-52, 90, 91, 100, 111, 174

Building department, 5, 6, 17, 50

Building inspector, 6, 50, 90, 174

Built-up roofing, 218

Bullnose brick, 145, 146

## C

Cabinetwork, 256

Cantilever pan system, 120, 121

Cantilever truss, 215

Cap flashing, 220

Carpentry, finish, 155, 255

rough, 155-178, 255

Casement windows, 201, 202, 231

Cast stone, 226

Catch basins, 240

Caulking, 148, 152

Ceiling, hung plaster, 191, 192

Ceiling beam, 160, 203, 204

Cement, 108, 141

Cement finish, 179

Chair rail, 196, 205

Channels, steel, 213

Check lists, 64, 69, 70

Chimney cap, concrete, 186, 187

Cinder blocks, 141, 149, 151

Cinder concrete arches, 113-118, 126

Cinder floor fill, 183

City departments, 6, 50-52, 90, 174

Claw-plate connectors, 173, 175

Cleaning brickwork, 128, 135, 140

Clipped bond, 148

Closures, 142, 143

Coarse aggregate, 105, 108, 182

Code, building, 6, 50, 90, 100, 111, 174

Column covering, 133

Column forms, 103, 115

Columns, steel, 210-214

Comb-grain flooring, 206

Combination walls, 133, 134, 140

Common bond, 141, 143, 144

Common brick, 128, 130, 134, 141-144, 149

Composition roofing, 218

Concrete, controlled, 52

plain, 105

reinforced, 105

waste, 67, 68

Concrete arches, 113-127

Concrete blocks, 141, 149, 151

Concrete forms, 101-103, 108, 115, 127

Concrete foundations, 101-112

Concrete inserts, 103

Concrete joints, 103

Concrete joists, 118-120

Concrete mix, 105, 111

Concrete reinforcing, 101, 102, 106-111

Concrete stairs and steps, 125, 185, 186

Connectors, timber, 173, 175

Construction company, 22-24

Construction contracts, 54-60, 71, 72, 212

Construction department, 24, 82

Construction joints, 103

Construction relations, 4-8, 57, 249

Contingencies, 69

Contract, lump-sum type, 55, 57

management type, 54, 59

subcontract, 70, 212, 216

unfair dealings, 71, 212

Contract arbitration, 57

Contract definition, 54

Contract financing, 55

Contractor, duties, 17, 212

office, 4, 17-25

personality, 18, 25

personnel, 17, 18, 23

Controlled concrete, 52

Conventional indications, 31, 50, 246

Coping, terra cotta, 128

Copper flashing, 162, 163

Corner beads, 188-193

Corner braces, 160, 164, 169

Corner post, 159

Cornices, stone, 221, 227

wood, 196, 203, 221

Cost-plus contracts, 54, 59

Cost records, 19, 21, 22

Counter flashing, 220

Cow stall, 185

Crickets, roof, 220

Cross bridging, 158, 164, 166

Cross section, 43, 267, 268

Curbs, concrete, 184

Curtain wall, 51

## D

Dampproofing, 147, 153, 258

Dense heart lumber, 156

Designation of doors, 198

Detail drawings, 31, 49, 50, 269  
 Diamond mesh lath, 191  
 Dimension lumber, 157  
 Door frames, 197, 229  
 Doors, fire, 52, 228, 230  
     fireproof, 228-234  
     hollow metal, 228, 233  
     kalamein, 228  
     rolling steel, 232, 234  
     tin-clad, 228, 230  
     wood, 195-198, 208  
 Dormer framing, 171  
 Dormer window, 33  
 Double-acting doors, 196  
 Double-hung window, 199, 200  
 Douglas fir, 156  
 Dove-tail, 205  
 Driveways, concrete, 180-184  
 Drop girt, 160  
 Ducts, 224, 242  
 Dutch bond, 142

## E

Easement, handrail, 201  
 Edge-grain flooring, 206  
 Electric symbols, 246  
 Electric work, 239, 243-246  
 Elevations, 30, 261  
 Elevator work, 239, 245, 260  
 Employee classifications, 7, 8, 82-85  
 Enclosure wall, 51  
 Engineering department, 23, 24, 82  
 Engineers, designing, 10  
 English bond, 141, 142, 144  
 Equipment and tool department, 24, 83  
 Estimate, arrangement, 62, 63  
     bidding, 61  
     divisions, 63, 75  
     preliminary, 61  
     summary, 91  
     working, 62  
 Estimator's responsibility, 1, 55, 65, 81,  
     179, 210, 239, 243, 248  
 Ethics of contracting, 56, 71, 91, 94, 173,  
     211  
 Excavating, 95-100  
     for mechanical trades, 239  
     specifications, 253  
 Exit, horizontal, 52  
 Expanded metal lath, 188-193

Expansion joint, 103  
 Expense, job, 81-94

## F

Fabric dampproofing, 147, 153  
 Face brick, 128, 130, 135, 141, 149  
 Federal laws, 17, 50, 90  
 Financing contracts, 55  
 Fine aggregate, 105, 108, 182  
 Finish carpentry, 155, 195-209  
 Finish grade, 95  
 Finish hardware, 236  
 Fink truss, 174, 215  
 Fir, 155, 196  
 Fire doors, 52, 228  
 Fire partitions, 52  
 Fire Underwriters' doors, 228  
 Fire walls, 51  
 Fire windows, 52, 228  
 Fireproof doors, 196, 228-234  
 Fireproof partition, 52  
 Flashing, chimney, 220  
     roof, 219  
     wall, 162, 163, 219  
     window, 200, 202  
 Flat arch, brick, 149  
 Flat grain flooring, 206, 207  
 Flat rib lath, 191  
 Flat slab construction, 115-118, 121-123  
 Flemish bond, 141, 143, 144  
 Float finish, cement, 180, 182  
 Floor arches, 113-127  
 Floor area, 52  
 Floor bridging, 158, 164, 166  
 Floor finishing, 237  
 Floor plans, 31, 262-266  
 Flooring, cement, 179-184  
     tile and terrazzo, 235  
     wood, 155-158, 162, 205-209  
 Flue lining, 128, 133, 140, 141  
 Footing, 41  
 Formwork, 101, 108, 113, 127  
 Foundations, concrete, 101-112  
 Four-way system, 122  
 Frame construction, 155-178  
 Frame house, 32-49  
 Framing around openings, 167, 168  
 Framing lumber, 156-171  
 Framing plans, 28, 30, 270-273

Frieze, 221  
Furring, terra cotta, 133

## G

General contractor, 17-25  
General job expense, 81, 119, 173, 237, 243  
Girders, concrete, 116, 118  
    steel, 210-213  
    wood, 161  
Girt, 160, 165; 169  
Glazed terra cotta, 136-140  
Glazing, 236-238, 257  
Grade marking, lumber, 156, 173  
Granite, 226-254  
Gravel roofing, 218  
Grillage beams, 222  
Grounds, 188, 196, 197, 205  
Grouting of steel, 211  
Guarantees, 89  
Gutters, box, 220  
    hanging, 221  
    lined, 203, 221  
    metal, 223, 224  
    standing, 220  
    wood, 203, 221  
Gypsum blocks, 128

## H

Handrails, wood, 201  
Hanger inserts, 123  
Hardeners, floor, 180  
Hardpan, 97  
Hardware, 236  
Header beam, 164, 174  
Headers, brick, 141-143  
Heating, 239-243, 259  
    temporary, 66, 69, 87  
Heavy clay, 97  
Herringbone brickwork, 142  
Hip rafter, 159, 171  
Hoisting, 119, 214  
Hollow block floor systems, 118-121  
Hollow metal, 228-233  
Horizontal exit, 52  
Hot water supply, 239  
House drain, 241  
Howe truss, 215

Human occupancy, 52  
Hung ceilings, plaster, 191, 192

## I

I-beams, 213  
Idaho pine, 160  
Inserts, 103, 123  
Inspector, architect's, 6, 13  
    municipal department, 6, 50, 90  
Inspector's daily report, 13, 14  
Insulation, 173, 174, 221  
Insurance, 90  
Integral cement finish, 180  
Iron, 210-217

## J

Jamb, door, 196-198  
    window, 199-203  
Job expense, 17, 81, 110, 119, 173, 237, 240, 243  
Job organization, 17, 24, 81, 253  
Joint, brick, 135, 142  
    construction, 104  
    expansion, 104  
    wood, 205  
Joist, 158, 161

## K

Kalamein, 196, 228, 255  
Keene's cement, 192  
King post truss, 215

## L

Labor department, 17, 50, 90  
Labor laws, 50, 85, 87, 90  
Laminated floor, 158  
Lathing, 188-193  
Laws, federal, 17, 50  
    municipal, 6, 17, 50, 87  
    state, 10, 17, 50, 85, 87, 90  
Laying out, 67, 85, 88, 89  
Layout engineer, 17, 23  
Leader line, 241  
Licensing, architects, 10-13  
    electrical contractors, 244  
    plumbing contractors, 240  
Lighting fixtures, 245

Limestone, 226, 254  
 Lines and batters, 88, 89  
 Lintels, 167, 210  
 Load-bearing terra cotta, 131, 132  
 Long-span roof slab, 120  
 Lumber, 155-169  
 Lumber grading, 156, 173  
 Lump-sum contracts, 55, 57

## M

Machine foundations, 245  
 Management contracts, 54, 59  
 Manholes, 240  
 Maple flooring, 155, 260  
 Marble, 235, 254, 257  
 Masonry anchors, 123, 124  
 Material department, 24, 83  
 Material men, 8, 17  
 Mathematics of estimating, 76-79  
 Mechanic, 8  
 Mechanical plan, 29, 30  
 Mechanical trades, 15, 238  
 Meeting rail, 199, 200  
 Membrane waterproofing, 222-224  
 Mesh, reinforcing, 107, 113, 117, 126  
 Metal pan system, 118-121  
 Metal lathing, 188-193  
 Mill construction, 158, 159  
 Millwork, 195-205  
 Mixtures of concrete, 105, 111  
 Monolithic finish, 180  
 Mortar, 144  
 Moulding profiles, 205  
 Mullion, 199, 200  
 Municipal departments, 6, 17, 50  
 Muntin, 202  
 Muriatic acid, 128, 135

## N

Nails, 170  
 N.C. pine, 155

## O

Oak flooring, 155, 206-209  
 Oil burners, 242  
 One-way floor, concrete, 119  
 Ordinary excavating, 97  
 Original grade, 95

Ornamental iron, 210, 215-217  
 Outlookers, cornice, 203  
 Overhead doors, 33, 196  
 Overhead expense, 81-94, 173

## P

Painting, 236, 258  
 Pan system, 118-121  
 Panel wall, 51  
 Parapet wall, 51  
 Partitions, 52, 128, 165  
 Pavements, concrete, 180-184  
 Payments on contracts, 55-60  
 Permits, 6, 17, 88  
 Photographs, progress, 88  
 Piles, 96, 97  
 Pine, 155, 156, 206  
 Place of assembly, 52  
 Plancia, 221  
 Plank floor, 158  
 Plans, 26-50, 65, 80, 261-273  
     architectural, 26-49, 261-269  
     bank, 261-273  
     house, 32-46  
     mechanical, 29, 30, 242  
     office building, 261-273  
     structural, 28, 30, 270-273  
 Plaster boards, 188  
 Plastering, 188-194, 257  
 Plastic flashing, 223  
 Plate, roof, 159, 171  
 Plate anchor, 203  
 Plumbing, 239, 259  
 Ponderosa pine, 160  
 Poplar, 156  
 Portland cement, 108, 141  
 Pratt truss, 174, 215  
 Precast slabs, 121  
 Preliminary estimates, 61  
 Present grade, 37  
 Private dwelling, 32-49, 52  
 Private sewer, 241  
 Progress photographs, 88  
 Progress schedule, 19, 20  
 Project manager, 24, 82  
 Protection, temporary, 66, 69, 88, 110  
 Protective assembly, 52  
 Public sewer, 241  
 Purchasing, 19, 24, 82

## Q

Quantity survey, 74-80

## R

Rabbeted door frame, 196-198  
 Rafter, 159-161, 171  
 Raised girt, 160  
 Raked joint, 135, 142  
 Rectangular mesh, 117  
 Red oak flooring, 206, 207  
 Reference line, 47  
 Reglet, flashing, 219  
 Reinforced concrete, 105  
 Reinforcing of concrete, 101, 106, 117  
 Reinforcing mesh, 107, 113, 117, 126  
 Reinforcing rods, 106, 109, 118, 123  
 Relieving arch, 149  
 Ribbon, 159, 168  
 Ridge, 171  
 Rock excavation, 96-98  
 Rods, reinforcing, 106, 109, 118, 123  
 Rolling steel doors, 232, 234  
 Roof arches, 113-127  
 Roof framing, 159, 171, 174  
 Roofing, 218-221, 258  
 Rough carpentry, 155-178  
 Rough wood buck, 196  
 Rowlock arch, 149  
 Rowlock brick, 141  
 Rubble stone, 226  
 Running bond, 144  
 Runways, temporary, 110

## S

Sand, 182  
 Sanitary sewer, 241  
 Scaffolds, carpentry, 169  
     masonry, 140  
     steel erection, 210  
 Scale, 30, 43  
 Scale rule, 76  
 Scissors truss, 215  
 Scratch coat, plaster, 192  
 Section, 30, 267  
     door, 196-198  
 Segmental arch, 149  
 Sewers, 240, 241  
 Shaft, 52

Sheathing, 156, 159, 169, 170  
 Sheet metal, 218-225, 258  
 Sheet piling, 96  
 Shiplap, 205  
 Shop drawing, 9, 210-212  
 Short-leaf pine, 155, 156  
 Short-span roof tile, 121  
 Show windows, 228  
 Shower room, 223  
 Side of trim, 200  
 Sidewalk shed, temporary, 87  
 Sidewalks, 183  
 Siding, 160, 162  
 Sill, building, 159-163, 168  
     stone, 199, 201  
     window, 199-202  
 Site examination, 68  
 Skeleton sheeting, 96  
 Skewback, 149  
 Skylights, 224  
 Slab, concrete, 113-126  
     flat, 115-122  
     forms, 103, 113, 115  
     inserts, 123  
     long-span, 120  
     reinforcing, 113-123, 126  
 Slag roofing, 218  
 Slot anchors, 123, 124  
 Soffit clips, 113, 114  
 Soil pipe, 241  
 Soldier brick, 141  
 Southern pine, 156  
 Spandrel, 51, 153  
 Specification, analysis, 65  
     arrangement, 13, 15  
     importance, 249  
     loose phrases, 15, 71  
     for office building, 252  
     precedence, 15  
     use, 26  
     writing, 10, 13  
 Split ring connectors, 173, 175  
 Spruce, 155  
 Stack, plumbing, 241  
 Stall, cow, 185  
 Standing gutter, 221  
 State laws, 10, 17, 50, 85, 87, 90  
 State licenses, 10-13  
 Steel doors, 226, 232  
 Steel and iron, 67, 210, 254  
 Steel joist, 52

Steel sash, 231  
 Stirrups, 164  
 Stock size lumber, 155  
 Stonework, 226, 254  
 Stool, window, 199  
 Stops, door, 196  
 Storm sewer, 241  
 Stretchers, brick, 141, 143  
 Structural lumber, 156  
 Structural plans, 28, 30, 270-273  
 Stucco, 188, 192  
 Stud, 155, 158-171  
 Subflooring, 165-167  
 Subcontractor, approved, 71  
   definition, 6, 17  
   estimates, 69, 70, 216, 243  
   overlapping, 239-244  
   responsibility, 19, 212, 250  
   substitutions, 70  
 Summary sheet, 91, 92  
 Sun room, 203, 204  
 Supervision, 17-19, 81, 253  
 Surety bonds, 89  
 Surfaced terra cotta, 136-140  
 Surveys, 88  
 Suspended ceilings, 191, 192  
 Symbols, on plans, 31, 50, 246  
   for electric work, 246  
 Swimming pool, 223

## T

Tail beams, 164, 174  
 Take-off sheets, 64  
 Tamper, 183  
 Temporary construction, 66, 85, 110, 173  
 Temporary enclosures, 87  
 Temporary heating, 66, 69, 87  
 Temporary job office, 85-87, 253  
 Temporary light and power, 244  
 Temporary protection, 66, 69, 88, 110, 173  
 Temporary runways, 111  
 Temporary sidewalk shed, 87  
 Temporary stairways, 87  
 Temporary toilets, 87  
 Temporary water lines, 66, 87, 240  
 Termites, 161  
 Terra cotta blocks, 128-140  
   column covering, 133  
   coping, 128  
 Terra cotta blocks, flue lining, 128, 133, 140  
   furring, 133  
 Terrazzo, 235, 257  
 Tile, 235  
 Timber connectors, 173, 175  
 Timbers, 155, 159  
 Time and cost department, 24, 83  
 Tinclad doors, 228, 230  
 Title boxes, 27, 30  
 Tongue and groove, 205  
 Toothed-ring connectors, 173, 175  
 Topsoil, 97  
 Trenches for piping, 239  
 Triangle mesh, 117  
 Trimmer beam, 164, 174  
 Trowel cement finish, 182  
 Trusses, 174, 176, 215  
 Twist, handrail, 201  
 Two-way floor system, 122

## U

Underflooring, 206  
 Unfair dealings, 55, 69-72, 91, 173  
 Union regulations, 50, 85, 236, 238, 244  
 Union wage rates, 7, 8

## V

Veneer, brick, 151  
 Ventilating, 243  
 Vent pipe, 241

## W

Wage rates, 7, 8  
 Wales, 96  
 Walks, cement, 180-184  
 Wall, definitions, 51  
 Wall forms, 101-103, 127  
 Wall mouldings, 196  
 Wall sheathing, 156, 159, 169, 170  
 Wall ties, 148  
 Warren truss, 174, 215  
 Waste, in carpentry, 68, 170  
   in concrete and masonry, 67, 68  
   an element of cost, 67, 68  
   in wood flooring, 206  
 Waste pipe, 241  
 Water supply, temporary, 66, 87  
 Water tables, 162, 163

- Waterproofing courses, 153
  - Waterproofing membrane, 222-224
  - White oak flooring, 206, 207
  - White pine, 156, 196, 208
  - Whitewood, 156
  - Wide-flange beams, 212
  - Windows, fire, 52
    - fireproof, 228
    - steel, 231
    - wood, 199-202
  - Winter conditions, 69, 87
  - Wire mesh for concrete, 107, 111, 117
  - Wood cornices, 203
  - Wood doors, 196-198, 208
  - Wood float finish, 180, 182
  - Wood flooring, 205-209
  - Wood framing, 156-171
  - Wood grading, 156, 173
  - Wood lath, 188
  - Wood windows, 199-202
  - Working estimates, 62, 75
  - Workmen, 7, 8
- Y
- Yard lumber, 155





